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JANUARY 2002

OU-4 Focused Feasibility Study Report
Greenwood Chemical Company
Superfund Site
Newtown, Albemarle County, VA

FINAL

JANUARY 2002

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EXECUTIVE SUMMARY

The U.S. Army Corps of Engineers (USACE) was tasked by the U.S. Environmental Protection Agency (EPA) to prepare a Focused Feasibility Study (FFS) for Operable Unit 4 (OU-4) at the Greenwood Chemical Superfund Site. OU-4 addresses all site deep soils, the former lagoon known as Backfill Northeast, the former process building B and C area, and the Northern Warehouse area. The Greenwood Chemical Company manufactured a variety of chemicals at this site, with applications in industrial, agricultural, pharmaceutical and photographic processes. Operations at the site began in 1947 and were terminated in 1985. The site was listed as a National Priorities List site in July 1987. A Remedial Investigation completed in 1990 identified 19 contaminants of concern (COCs) for the site.

The objectives of the FFS were 1) to verify deep-soil cleanup goals that would be protective of groundwater in OU2; and 2) to evaluate a limited range of remedial alternatives that address the risks posed by the soils. The remedial action objectives for OU4 are:

- Limit migration of the contaminants of concern that would result in groundwater concentrations that exceed the OU2 cleanup goals,

- Decrease potential future risk due to direct contact with contaminated surface soil, and

- The eventual remediation of OU-4 soil to meet preliminary remediation goals (PRGs).

Within OU4 there are two primary areas of concern, the former main manufacturing area and the former drum disposal area. An analysis of the potential applicable or relevant and appropriate requirements (ARARs) was completed to identify legal requirements that could impact the selection of a remedial alternative. Location and action specific ARARs were identified that could impact the selection of an alternative. No chemical-specific ARARs were identified for the 19 COCs in the deep soils. Preliminary remediation goals were developed for the site to protect groundwater in OU-2 and limit risk to receptors from direct contact with site soils. These PRGs were based on leach tests performed by USACE and exposure models/toxicity data developed by EPA Region III. Of the 19 COCs, 12 are present in OU-4 soils above the PRGs.

The general response actions (GRAs) evaluated in the FFS evaluated for OU4 included no action, excavation, capping (permeable and impermeable) as well as combinations of these actions. Based on the GRAs, a set of remedial alternatives was developed for the two areas of concern. The remedial alternatives were evaluated against the nine criteria in the National Contingency Plan. A detailed analysis will be performed using seven of the nine evaluation criteria established by the EPA in 40 CFR 300.430(e)(9)(ii). The last two criteria, State Acceptance and Community Acceptance will be evaluated after the state and community have reviewed the report and commented on the Proposed Plan.

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ARAR	Applicable or Relevant and Appropriate Requirements
AWQC	Ambient Water Quality Criteria
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	Contaminants of Concern
DAF	Dilution/Attenuation Factor
EPA	U.S. Environmental Protection Agency
FFS	Focused Feasibility Study
FS	Feasibility Study
GIS	Geographic Information System
GMS	Department of Defense Groundwater Modeling System
GRA	General Response Action
HBL	Health-Based Limit
HI	Hazard Index
MCL	Maximum Contaminant Limit
MCLG	Maximum Contaminant Level Goal
MSL	Mean Sea Level
NAA	Naphthalene Acetic Acid
NCP	National Contingency Plan
NPL	National Priorities List
OU	Operable Unit
O&M	Operation and Maintenance
PRAP	Proposed Remedial Action Plan
PRG	Preliminary Remedial Goal
RACER	Remedial Action Cost Engineering and Requirements System
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
ROD	Record of Decision
SDWA	Safe Drinking Water Act
SPLP	Synthetic Leachate Testing Procedure
SSL	Soil Screening Level
SVE	Soil Vapor Extraction
TBC	To-Be-Considered
TIC	Tentatively Identified Compounds
TSDF	Transport, Storage and Disposal Facility
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
VADEQ	Virginia Department of Environmental Quality
VOC	Volatile Organic Compound
VWQC	Virginia Water Quality Criteria

1. INTRODUCTION

The U.S. Environmental Protection Agency (EPA), Region III tasked the U.S. Army Corps of Engineers (USACE), under an interagency agreement, to prepare a Focused Feasibility Study (FFS) for Operable Unit (OU) -4 at the Greenwood Chemical Superfund Site. OU-4 was established to address deep soil contamination beyond the limits of the OU-1 soil removal activities, but above the water table.

The following objectives were established for the FFS:

- Limit migration of the contaminants of concern (COCs) that would result in groundwater concentrations that exceed the OU-2 cleanup goals,

- Decrease potential future risk due to direct contact with contaminated surface soil, and

- The eventual remediation of OU-4 soil to meet preliminary remediation goals (PRGs).

To accomplish these objectives, the following tasks were performed:

- Background documentation review
- Creation of a Geographic Information System (GIS) database
- Evaluation and interpretation of data
- Verification of the risk-based cleanup goals for the protection of groundwater
- Collection of soil samples
- Performance of Focused Feasibility Study Evaluation
- Preparation of a Focused Feasibility Study Report

1.1 SITE DESCRIPTION

The Greenwood Chemical Company Superfund Site is located in the village of Newtown, Albemarle County, Virginia, between the cities of Waynesboro and Charlottesville. A Vicinity Map is presented in Figure 1-1 and a Site Location Map is presented in Figure 1-2. Approximately 18 acres of the 33.59 acres owned by the company were associated with chemical manufacturing and waste disposal activities. These 18 acres comprise the Greenwood Chemical Company Superfund Site. The Greenwood Chemical Company manufactured a variety of chemicals at this site, with applications in industrial, agricultural, pharmaceutical and photographic processes. Operations at the site began in 1947 and were terminated in 1985. The site was listed as a National Priorities List (NPL) site in July 1987.

Site features included chemical processing buildings (former Buildings A, B, and C), offices and laboratory space, storage trailers and sheds, a pump house, a concrete bunker, seven treatment lagoons, several abandoned structures, and a buried drum area. Original site features are shown on Figure 1-3. Based on preliminary investigations, the site was grouped into four Operable Units, as follows:

OU-1 Addresses chemical containers, the Backfill North area, waste dump area, former drum disposal area, former East Drum Area (also known as the 935 square), former Process Building A, and sludge and lagoon soils from Lagoons 1, 2 and 3. The ROD for OU-1 selected off-site incineration of sludge and soil, and off-site disposal of chemical containers. The OU-1 remedial action was completed in the fall of 1996.

OU-2 Addresses groundwater, and surface water in lagoons 4 and 5. An interim ROD for OU-2 mandates the installation of a groundwater pump-and-treat system to retard plume migration. The system has been in operation since the spring of 2001. A final ROD for OU-2 will be issued after further evaluation of the interim action.

OU-3 Addresses onsite process buildings that were removed by the USACE Omaha District Rapid Response contract. This action was completed in the spring of 1993.

OU-4 Addresses the deep soils above the groundwater, but beyond the limits of the OU-1 soil removal activities. Also included are 1) the former lagoon known as "Backfill Northeast" associated with former Process Buildings B and C (potential arsenic contamination in shallow soil); 2) the vicinity area of former Process Buildings B and C, where the in-field bioventing treatability study was performed; and 3) the Northern Warehouse Area (potential acetone and arsenic contamination in the shallow soil), in the event subsequent soil sampling reveals contamination concentrations above established health based levels. This FFS addresses only the media in OU4.

1.2 Site History

Presented here is a brief summary of the operational history of chemical activities performed at the site presently identified as the Greenwood Chemical Superfund Site. A complete discussion of the operational history of the site is found in the Remedial Investigation (RI) Report, dated August 1990 (Ebasco, 1990).

The Greenwood Chemical Company, an 18-acre site in Albemarle County, Virginia, manufactured specialty chemicals for approximately 40 years. Manufacturing of specialty chemicals began at the site in 1947. Major processing operations ceased in April 1985. A variety of chemical products with applications in industrial, agricultural, pharmaceutical and photographic processes have been manufactured on the premises. The primary products manufactured at the site included alpha naphthalene acetic acid, which is a product used to prevent fruit from falling before it can be harvested; 1-naphthaldehyde, a product used in metal plating; and naphthoic acid, a product associated with photography. According to the Virginia Bureau of Toxic Substances, one to ten tons of cyanide per year was used by the Greenwood Chemical Company. In addition, arsenic salts were used as catalysts in producing chloromethylnaphthalene, an intermediary in the production of naphthalene acetic acid. (Ebasco Services, 1990)

After an April 1985 toluene explosion and fire that killed four workers, the facility ceased operations. Water and sludge from former lagoons, drums containing unknown wastes and materials (on the surface and buried), and contaminated soils were present at various locations on the site. The most prevalent contaminants were toluene, naphthalene, various naphthalene derivatives, arsenic, and cyanide.

In April 1988, the Environmental Protection Agency (EPA) conducted a removal action at the site to stabilize and contain the hazardous wastes. Actions included:

- treatment of lagoon water and stabilization of lagoon sludge with fly ash,
- excavation of approximately 520 drums from the drum disposal area,
- construction of diversion/drainage ditches to reduce surface water run-on infiltration and erosion,
- installation of monitoring wells, and
- sampling and analysis of groundwater from the monitoring wells and area residential wells.

Manufacturing activities at the site involved the handling of a large number of drums containing various waste, feedstock, intermediate, and final products. Historical aerial photos show tens to hundreds of drums in the vicinity of the process buildings throughout the 1970's and early 1980's. According to interviews with Greenwood Chemical employees, chemical containers were routinely buried on-site. The primary disposal site was a trench located along the western boundary of the site. This area is identified on the site map as the former drum disposal area. Other areas used for storage and/or disposal of containerized wastes include an area adjacent to the elongated material-handling shed west of Building A and a wooded area on the northeastern corner of the property. All drums were removed from the trenches during EPA's removal activities. Included in Appendix F of the RI is a Virginia Bureau of Toxic Substances database list of over 70 chemicals used at the site from 1982 to 1985 (Ebasco). See Figure 1-3 for locations of former process buildings and disposal areas.

Homes, farms, and community buildings are proximate the site. Approximately 1,600 people, living within three miles of the site, are dependent on private wells as their source of drinking water.

1.3 REPORT ORGANIZATION

The FFS Report is organized into the following sections:

- Section 1: Introduction – This section introduces the objectives for this FFS, and provides a brief description of the operable units.

- Section 2: Physical Characteristics – This section contains limited background information on the physical characteristics of the project site as well as a summary of historical information for the site, with a specific focus on OU4.
- Section 3: Preliminary Remediation Goals – This section develops the remedial goals for the project based on threats to groundwater, direct contact, and appropriate legal requirements.
- Section 4: This section described the nature and the extent of the contamination at the site with respect to the remedial goals developed in Section 3. In addition, it summarizes pre-remedial design sampling and analysis activities that were conducted in support of the FFS.
- Section 5: Identification and Screening of Technologies – Remedial action technologies are identified and screened.
- Section 6: Detailed Analysis of Alternatives – Presents the relevant information utilized to evaluate each alternative against the required evaluation criteria. A detailed analysis and comparative analysis of the alternatives is performed.
- Section 7: References

In addition there are several attachments that contain field data and data analysis that support the conclusions in the text.

2.0 PHYSICAL CHARACTERISTICS

This section presents a summary discussion of the physical characteristics of the site. A complete discussion of the site's physical characteristics is found in the Remedial Investigation Report, dated August 1990. This section will briefly summarize the information from the RI believed to be critical to the FS decision making process. Also in this section, changes to the physical features which occurred after the finalization of the RI will be discussed.

2.1 SURFACE FEATURES

The topography at the site slopes predominantly to the southeast. Total relief across the site is approximately 196 feet, with an average grade of 10 percent. The maximum site elevation, 1013 feet MSL, occurs at the northeastern corner of the property. The lowest point on the site, 817 feet MSL, is along the southern property boundary where the drainage swale from South Pond intersects the West Stream. (Ebasco Services, 1990)

Since the completion of the RI, there have been some changes made to the surface features of the site. On-site process buildings have been removed. There has also been significant alteration and regrading of the site associated with excavation of soils in the Backfill North area, the Drum Disposal area, the Waste Dump area, the former East Drum Area (935 Square), Process Building A area, and Lagoon 1, Lagoon 2 and Lagoon 3 areas.

The former East Drum Area is commonly referred to as the 935 Square due to the square cut excavation created during the 1996 remediation efforts. The lower excavation contour is at a grade of 935 feet above sea level. Excavation contours of the 1996 remediation efforts are presented on Figure 2-1. Upon completion of the excavation, the former lagoons and drum disposal areas were backfilled, and the site was regraded as shown in Figure 2-2.

During construction of the OU2 groundwater treatment facility, overburden material was removed to provide a level construction area. Following sampling of the overburden material to confirm the soils removed from this area were free of contamination, the material was placed in the former manufacturing area, just south of the office/administration area. The relocated material forms a terrace which overlies former process buildings A, B, and C, the former East Drum Area (935 square), the former backfill northeast area, and most of the former backfill north area. Sampling results for the relocated material is presented in Attachment 1. Figure 2-3 presents a site map showing the topography following placement of the relocated material. The contours labeled "top soil" represent the excavated clean soil from the pump and treat system. Contours designated as "graded fill" represent site conditions after completion of OU1 remedial activities.

2.2 SITE GEOLOGY

The overburden at the Greenwood Chemical site is comprised of soil and a relatively thick saprolite sequence. Bedrock, identified as a Precambrian gneiss belonging to the Pedlar Formation, crops out in the southwestern portion of the site near MW-12, and adjacent to the road that forms the northern boundary of the site. Reference Figure 2-4 to see the location of MW-12. Overburden thickness is greatest along a northeast-southwest trending shear zone that transects the northern portion of the site.

Most of the site is covered with a colluvial soil, which ranges in thickness from 0 to 15 feet. The colluvial soil consists of parent rock fragments in a heterogeneous clayey matrix. Underlying colluvial soil is a relatively thick layer of saprolite formed from the in-situ chemical weathering of the bedrock. The lithology of the saprolite encountered was similar across the site. The upper portion of the saprolite is a mottled yellowish-red to yellowish-brown silty clay with little relict rock structure present.

Reference Attachment 2, 1997 Sampling Summary Report, Geotechnical data. Due to the high clay content present at the site, approximately 30% clay by weight, technologies involving air movement through the vadose zone were screened out. These technologies included soil vapor extraction and bioventing.

From the surface soil to bedrock, clay content decreases with depth. The percentage of silty and sand size particles increases, relict rock structure becomes more apparent, color changes to light yellowish-brown, and veins of kaolinite-rich clay occur. As the saprolite grades into weathered bedrock, the texture becomes increasingly granular (Ebasco Services, 1990).

Competent rock was generally encountered below groundwater, however auger refusal was often encountered at significantly shallow depths and is often above the water table. Auger refusal at depths less than 10 feet were encountered in both the former lagoon 3 area and the former drum disposal area. Shallow auger refusal may also be encountered elsewhere on the site.

2.3 SITE HYDROGEOLOGY

Groundwater at the site is present in both the overburden and bedrock horizons. Aquifer tests indicate these two units exhibit a degree of hydraulic connection sufficient to consider the units to be part of a single, unconfined to semi-confined aquifer system. The water table at the site occurs in the overburden at depth varying from less than 5 feet to more than 35 feet below ground surface. The water table is essentially a subdued reflection of local topography. Groundwater in the overburden flows in a southeasterly direction toward eventual discharge into the West Stream (Ebasco, 1990). However, groundwater in the bedrock flow system is not confined by this boundary. Rather, groundwater in the bedrock flow system is controlled by the nature and extent of bedrock fracturing. The groundwater elevation contour map presented in Figure 2-4 was constructed based on data recorded in February 2001.

With the exception of MW-11, the water table is located above the overburden-bedrock interface. At MW-11, the water table has historically fallen below the overburden-bedrock interface. Generally, in the northern portion of the site, the water is found in the saprolite; to the south where the water table is closer to land surface, saturated soil conditions are encountered (Ebasco, 1990).

2.4 Soil and Vadose Zone Information

Much of the shallow overburden south of the former process buildings (former Buildings A, B, and C) had been extensively reworked during the construction of waste lagoons, excavation and burial of drums in the Drum Disposal Area, and excavation and regrading associated with the remediation of OU-1. OU-1 excavations were backfilled with a red-brown clay which is distinctly different from the natural site soils. In addition to the above-mentioned activities, during construction of the OU-2 groundwater treatment facility, excess soil/rock excavated during the construction process were placed south of the office/administration area, as discussed in Section 2.1 Surface Features. Existing site conditions are shown in Figure 2-3. Figure 2-3 shows stationing intervals for cross sections cut through the manufacturing area. Cross sections are presented in Figures 2-5 through 2-8. The cross-sections show the various modifications to the soils in the manufacturing area.

Samples of the vadose zone soils were collected and analyzed for engineering and physical properties during the supplemental sampling event. Samples collected ranged in depth from 6.0 feet to 32.0 feet. With the exception of the disturbed areas, the soils are very uniform across the site. Soils are predominantly classified as light-brown to brown sandy silt with some clay. Generally, as auger refusal is approached, the soils have a lower silt and clay content and are classified as a silty sand. These silty sands have more of a red-brown color than found in the sandy silts. Average moisture content of the samples tested is 36.6% with higher moisture contents in the silts and lower moisture contents in the sands. Average specific gravity is 2.57. Geotechnical data collected during the supplemental sampling event are contained in Attachment 2.

Also as part of the supplemental sampling program, samples of the vadose zone soils were collected for soil chemistry characteristics to evaluate the movement of the various site contaminants through the site soils, and to evaluate the availability of contaminants to biological systems. The results of the soil chemical and aerobic plate count analysis performed during the supplemental sampling event are contained in Attachment 2.

3.0 PRELIMINARY REMEDIATION GOALS

This section of the FFS establishes preliminary remedial goals (PRGs) for specific contaminants and media of concern and potential exposure pathways that will met the remedial action objective. Initially, the PRGs were based on readily available information, such as chemical-specific applicable or relevant and appropriate requirements (ARARs) or other reliable information. The PRGs were modified, as more information became available during FFS process, and are now risk based. Final remediation goals will be determined when the remedy is selected in the Record of Decision.

Remediation goals establish acceptable exposure levels that are protective of human health and the environment and shall be developed by considering ARARs under federal or state environmental or facility siting laws and the following factors:

- For systemic toxicants (i.e., non-carcinogens), acceptable exposure levels shall represent concentration levels to which the human population, including sensitive subgroups, may be exposed without adverse effect during a lifetime or part of a lifetime, incorporating an adequate margin of safety;
- For known or suspected carcinogens, acceptable exposure levels are generally concentration levels that represent an excess upper bound life-time cancer risk to an individual of between 10^{-4} and 10^{-6} using information on the relationship between dose and response. The 10^{-6} risk level was used as the point of departure for determining remediation goals for alternatives when ARARs are not available or are not sufficiently protective because of the presence of multiple contaminants at a site or multiple pathways of exposure;
- Factors related to technical limitations such as detection/quantification limits for contaminants;
- Factors related to uncertainty; and
- Other pertinent information.

Maximum contaminant level goals (MCLGs), established under the Safe Drinking Water Act (SDWA), that are set at levels above zero, also play a role in the development of PRGs. As stated in the National Contingency Plan (NCP), they shall be attained by remedial actions for ground or surface waters that are current or potential sources of drinking water, where the MCLGs are relevant and appropriate under the circumstances of the release based on the factors in 40 CFR 300.400(g)(2). If an MCLG is determined not to be relevant and appropriate, the corresponding maximum contaminant level (MCL) shall be attained where relevant and appropriate to the circumstances of the release.

Where the MCLG for a contaminant is set at a level of zero, the MCL promulgated for that contaminant under the SDWA was used as the remedial level for ground waters that are potential sources of drinking water, where the MCL is relevant and appropriate under the circumstances of the release based on the factors in 40 CFR 300.400(g)(2). Use of groundwater is not part of this FFS and is addressed as OU2; however, protection of the on-site groundwater, at the MCL, is part of this FFS and details are presented below.

3.1 Baseline Risk Assessment Summary

As a part of the RI performed for the Greenwood Chemical site, a baseline risk assessment was performed to examine the potential impacts of past operations on human health or the environment by Ebasco Services (Ebasco, 1990). The baseline risk assessment examined risks/hazards to human and ecological receptors under a current use scenario and a future use scenario. A brief summary of the baseline risk assessment is presented in the following sections.

3.1.1 Baseline Human Health Risk Assessment

The human health risk assessment assessed the impact of COCs in the shallow soils, surface water, and groundwater based on a future use scenario. The baseline risk assessment in the RI did not directly address the risk or hazard posed by COCs in the deep soil.

Because volatile and semi-volatile tentatively identified compounds (TICs) were significant components of the site contamination, surrogates having similar toxicological information were selected for use in the baseline risk assessment. Tetrahydrofuran was used as a surrogate for the volatile TICs and naphthalene acetic acid (NAA) was used as a surrogate for the semi-volatile TICs for the purpose of calculating risk and hazard.

The results of the human health and environmental risk assessment indicated that for the current use scenarios, carcinogenic risks exceed 10^{-6} for the direct contact of surface soils by trespassers only in the reasonable maximum exposure scenario. The highest carcinogenic risk is $3x10^{-5}$ for this scenario. Arsenic was the main contributor to risk at the site. For non-carcinogenic effects the hazard index did not exceed 1 in any current use scenario.

For future use scenarios, carcinogenic risk exceeded 10^{-6} in every case except for risks associated with wading and swimming in an average case scenario. In all cases, arsenic was the primary contributor to the total excess cancer risk. Tetrahydrofuran and NAA did not contribute significantly to the excess upper bound lifetime cancer risk for the future groundwater use scenario. The non-carcinogenic hazard index exceeded 1 only for the reasonable maximum exposure scenario for groundwater ingestion. For this pathway, the hazard index (HI) of 6 was due primarily to tetrahydrofuran (HI=2.2) and NAA (HI=3.5).

3.1.2 Baseline Ecological Risk Assessment Summary

The RI report (Ebasco, 1990) evaluated risks to ecological receptors. The risks due to chronic exposures to several COCs could not be determined due to the lack of chronic toxicity information. The shallow arsenic-contaminated soils may adversely impact terrestrial plant life. Sensitive species of plants may be adversely affected across the majority of the Greenwood Chemical Site. More resistant species (such as grasses) may be adversely affected in isolated location where concentrations exceed 500 mg/kg of arsenic in the soil. The shallow soils posed no excessive acute toxicity risks to terrestrial animals. Cyanide exceeded both the Federal acute and chronic Ambient Water Quality Criteria (AWQC) and the Virginia Water Quality Criteria (VWQC) in lagoons 4 and 5 thus presenting a potential risk to aquatic organisms. Cyanide exceeded the Federal chronic AWQC and VWQC in South Pond. No conclusions were made concerning the source of the cyanide (surface water run-off versus groundwater) found in the surface water bodies.

Based on the data collected to support the RI, the report concluded that there was no excessive ecological risk posed by the COCs found in the OU4 soils; however, the shallow arsenic-contaminated soil may potentially pose some risk to terrestrial plants.

3.2 HEALTH-BASED REMEDIATION GOALS

3.2.1 Human Health-Based Goals - Soil

The human health-based goals for the shallow soils (0-2 ft) were developed by EPA (1999; 2000), as documented in Attachment 3. The future-use receptor was based on a recreational user (e.g., older child at a ball field). The two identified COCs in the surface soil are cyanide and arsenic. Briefly, the receptor was assumed to be at the site 48 days/year (3 times a week in warmer months) for 4 hours a day based on activity times listed in the EPA's Exposure Factor's Handbook (EPA, 1997). The ingestion rate was assumed to be 50 percent of the typical residential receptor. The target risk level was $1x10^{-6}$ and the target hazard index as 1.0. The cleanup level for arsenic is driven by its carcinogenic health effect whereas its non-carcinogenic health effects drive the cleanup goal for cyanide.

Given that direct contact with deep soils is not anticipated under the recreational receptor scenario, human health based goals for the deep soils (greater than 2 ft bgs) were not developed.

It should be noted that a significant portion of the site is now covered with clean fill from the construction of the groundwater treatment plant for OU2. Placement of the fill material on portions of the site, at depth of up to 20 ft., has eliminated the exposure pathway. Therefore, the cleanup goals for shallow soils may already be achieved at some locations, through the use of the clean fill cap.

3.3 GROUNDWATER PROTECTION-BASED GOALS

Although not a medium addressed specifically in this FFS, groundwater protection goals were developed so that OU-2 (the groundwater OU) would not be impacted adversely by the concentrations of chemicals in the vadose zone soils. Site-specific groundwater protection goals were determined based on 1) fate and transport modeling and 2) soil leachability testing.

A comparison of the modeled and the leachate-test derived groundwater-protection goals are presented in Table 3-1. In some cases, the leachate-determined goal was greater than the modeled goal. However, there are notable exceptions where the modeled goal is significantly higher than leachate-determined goal (e.g., acetone, chlorobenzene, and tetrahydrofuran). Due to the ability of the SPLP-East testing to examine the soil matrix effects and the presence of multiple compounds, the leachate-derived goals were selected as being more reflective of actual site conditions.

3.3.1 Modeled Groundwater Protection Goals

First, the fate and transport modeling effort is documented in the report *Final Fate & Transport Modeling for Determination of Soil Cleanup Goals Protective of Groundwater*, (Haliburton NUS, 1993). USACE, Baltimore reevaluated the risk-based cleanup goals established as a result of the fate and transport modeling. The fate and transport model was reviewed and found to be acceptable, although because of the absence of a sensitivity analysis for the model used in the development of the clean-up goals, there is great uncertainty associated with the model groundwater protection goals.

3.3.2 Leachate-Derived Groundwater Protection Goals

Second, groundwater protection goals were developed for soils greater than 2 ft deep through leachability testing using on-site soils. The groundwater protection goals were developed with leach testing using EPA method SW 846 1312, Synthetic Leachate Testing Procedure-East (SPLP-East). The distinction between the standard SPLP procedure and SPLP-East procedure is in the pH control during the determination of the analytes. The pH is adjusted to slightly below 7 (in the acid side) for the SPLP-East procedure because the soils East of the Mississippi River are generally acidic, and the SPLP-East procedure simulates that condition.

Method 1312 is designed to determine the mobility of both organic and inorganic analytes present in liquids, soils, and wastes. Samples were collected from various locations across the site at various depths to capture a wide range of site conditions and chemicals concentrations. The sample locations are shown in Attachment 9.

Initially, an on-site groundwater protection goal assumes that a receptor well is located on site. The soil concentration determined to be protective of an on-site groundwater well was determined by selecting the highest total soil concentration that did not result in the leachate concentration exceeding the MCL or health-based limit (HBL) as listed in the Attachment D of the EPA's Soil Screening Level (SSL) User's Guide (EPA, 1996a). The highest soil concentration deemed protective was selected using the graphs in Attachment 4. Selecting points from the graph was used rather than the development of regression models, because of the presence of multiple chemicals. Preliminary regression models (both linear and logarithmic) developed for all chemicals were not deemed useful even when accounting for differences in soil type.

Subsequently, an on-site groundwater protection goal was developed that assumes a receptor well is located at boundary of the OU. To develop a soil concentration protective of an on-site groundwater well, the selected total soil concentration was multiplied by a dilution/attenuation factor (DAF) of 20. The DAF of 20 was selected because it is described as protective of source areas up to 0.5 acres in size (EPA, 1996b).

The on-site groundwater protection value was based on the MCL or HBL as listed in the Attachment D of the EPA's Soil Screening Level (SSL) User's Guide (EPA, 1996a). This is not the same as the groundwater cleanup goals developed for the OU2 pump and treat system, which are applicable at the facility boundary.

Note that the detection limit for 2,4,6 trichlorophenol (0.5 mg/L) in the SPLP-East test is greater than the health based limit of 0.008 mg/L. However, there was no 2,4,6 trichlorophenol detected in the site soil samples, so the fact that there was none detected in the leachate should not impact the development of a cleanup goal for this chemical.

The leachate-derived groundwater protection goal for tetrahydrofuran (which is representative of volatile organic compound (VOC) TICs) is much lower than the modeled value. The leach-derive goal is based on a single detected concentration of 22 μg/L in the leachate and 4,700 μg/kg in the soil at sample location BNO00-7. None of the other samples, even those with much higher detected concentrations, had detectable concentration in the leachate. Although there were no identified sampling or analysis problems with the sample, the result is inconsistent with the 27 other samples collected at OU4. Therefore, the leachate-derived goal is likely to b much higher than that reported in Table 3-1.

3.4 Background-Based Goals

Background concentrations of metals in soil were examined to determine if the natural background concentrations would be a limiting factor in the development of soil cleanup goals for inorganic chemicals. If the background concentrations of metals were higher than the risk-based PRG for soil, the background concentrations could limit the attainment of the cleanup goals. For example, if the soil cleanup goal for arsenic was 5 mg/kg, but the PRG for arsenic was 0.5 mg/kg, it would be extremely and potentially impossible to excavate all of the soil with arsenic concentration greater than the PRG. For this reason, the EPA has determined that remediation of a site to a concentration less than natural background is generally unwarranted and technically problematic (EPA, 1991).

As part of pre-remedial design investigation activities, ten soil samples from 0-1 ft bgs were collected and analyzed for metals. Surface soil samples were collected from up-gradient locations along the property boundary. Although samples were collected from only the surface soils, examination of the geologic boring from other investigations at the site does not show great vertical heterogeneity in soil type/composition. Therefore, the shallow surface-soil samples were assumed to be representative of the entire soil profile for deep and shallow soils.

Statistical analysis of background data for the 10 soil samples is contained in Attachment 5. The concentrations observed in soil samples for arsenic and cyanide (the primary COCs in the surface soil) indicate that natural background concentrations of metals will not be a limiting factor in remediation of the deep or surface soils. The maximum concentration of arsenic was 18 mg/kg and the maximum concentration of cyanide was 0.12 mg/kg. The risk-based cleanup goals for these two inorganic chemicals are much greater than their maximum background concentrations. Therefore, remedial actions to achieve the risk-based PRGs in the surface soil will not lead to a cleanup goal that is typically unachievable.

3.5 LEGAL AND REGULATORY -BASED GOALS

The NCP (see 40 CFR 300.430[e]) specifies that on-site Superfund remedial actions must attain federal standards, requirements, criteria, limitations, or more stringent state standards determined to be legally ARARs to the circumstances at a given site. Such ARARs typically are identified during the RI/FS stage and at other stages in the remedy selection process. To be applicable, a state or federal requirement must directly and fully address the hazardous substance, the action being taken, or other circumstance at a site. A requirement that is not applicable may be relevant and appropriate if it addresses problems or pertains to circumstances similar to those encountered at a site. While legally applicable requirements must be attained, compliance with relevant and appropriate requirements is based on the discretion of the lead agency.

3.5.1 Scope of Federal ARARs

The scope and extent of ARARs that may apply to a response action will vary depending on where remedial activities take place. For on-site response activities, the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) does not require compliance with administrative requirements of other laws. CERCLA requires compliance with only the substantive elements of other laws, such as chemical concentration limits, monitoring requirements, or design and operating standards for waste management units for on-site activities. Administrative requirements, such as permits, reports, and records, along with substantive requirements, apply only to hazardous substances sent off site for further management. The extent to which any type of ARAR may apply also depends upon where response activities take place. Applicable requirements are universally applicable, while relevant and appropriate requirements only affect on-site response activities. Many federal statutes and their accompanying regulations contain standards that may be applicable or relevant and appropriate at various stages of a response action.

Laws and requirements enforced by agencies other than EPA may also be applicable or relevant and appropriate at a site. During on-site response actions, ARARs may be waived under certain circumstances. A state ARAR may be waived if evidence exists that the requirement has not been applied to other sites (NPL or non-NPL) or has been applied variably or inconsistently. This waiver is intended to prevent unjustified or unreasonable state restrictions from being imposed at CERCLA sites. In other cases, the response may incorporate environmental policies or proposals that are not applicable or relevant and appropriate, but do address site- specific concerns. Such to-be-considered (TBC) standards may be used in determining the cleanup levels necessary for protection of human health and the environment. ARARs must be identified on a site-by-site basis. Features such as the chemicals present, the location, the physical features, and the actions being considered as remedies at a given site will determine which standards must be heeded. The lead and support agencies (i.e., EPA and Virginia Department of Environmental Quality (VADEQ)) are responsible for the identification of ARARs.

ARARs are used in conjunction with risk-based goals to govern response activities and to establish cleanup goals. ARARs are often used as the starting point for determining protectiveness. When ARARs are absent or are not sufficiently protective, EPA uses data collected from the baseline risk assessment to determine cleanup levels. ARARs thus lend structure to the response process, but do not supplant EPA's responsibility to reduce the risk posed to an acceptable level. Determining exactly which laws and regulations will affect a response is somewhat different than determining the impact of laws and regulations on activities that take place outside the boundaries of a Superfund site. For instance, for on- site activities, CERCLA requires compliance with both directly applicable requirements (i.e., those that would apply to a given circumstance at any site or facility) and those that are deemed relevant and appropriate (even though they do not apply directly), based on the unique conditions at a Superfund site.

CERCLA, in addition to incorporating applicable environmental laws and regulations into the response process, requires compliance with other relevant and appropriate standards which serve to further reduce the risk posed by a hazardous material at a site. Relevant requirements are those cleanup standards, standards of control, or other substantive environmental provisions that do not directly and fully address site conditions, but address similar situations or problems to those encountered at a Superfund site. Resource Conservation and Recovery Act (RCRA) landfill design standards could, for example, be relevant to a landfill used at a site, if the wastes being disposed of were similar to RCRA hazardous wastes. Whether or not a requirement is appropriate (in addition to being relevant) will vary depending on factors such as the duration of the response action, the form or concentration of the chemicals present, the nature of the release, the availability of other standards that more directly match the circumstances at the site, and other factors (40 CFR 300.400(g)(2)). In some cases, only a portion of the requirement may be relevant and appropriate. The identification of relevant and appropriate requirements is a two-step process; only those requirements that are considered both relevant and appropriate must be addressed at CERCLA sites.

Environmental laws and regulations generally fit into three categories: 1) those that pertain to the management of certain chemicals; 2) those that restrict activities at a given location; and 3) those that control specific actions. Therefore, there are three primary types of ARARs. Chemical-specific ARARs are usually health- or risk-based restrictions on the amount or concentration of a chemical that may be found in or discharged to the environment. Location-specific ARARs prevent damage to unique or sensitive areas, such as floodplains, historic places, wetlands, and fragile ecosystems, and restrict other activities that are potentially harmful because of where they take place. Action-specific ARARs control remedial activities involving the design or use of certain equipment, or regulate discrete actions.

The types of legal requirements applying to responses will differ to some extent depending upon whether the activity in question takes place on site or off site (the term "on site" includes not only the contaminated area at the site, but also all areas in close proximity to the contamination necessary for implementation of the response action). Remedial actions must comply with all substantive requirements that are "applicable" or "relevant and appropriate." For remedial actions conducted off site, compliance is required only with applicable requirements, but both substantive and administrative compliance are necessary. Thus, compliance on site is broader in some respects, and narrower in others, than would be required where similar actions were conducted outside the CERCLA context (e.g., if a private party were doing an entirely voluntary cleanup on its own property). On-site compliance is broadened by the need to comply with "relevant and appropriate" as well as "applicable" requirements. Activities conducted on site would have to comply with all ARARs; those conducted off site would have to comply only with applicable requirements. Congress limited the scope of the obligation to attain administrative ARARs through CERCLA Section 121(e), which states that no federal, state, or local permits are required for on-site Superfund response actions. The lack of permitting authority does not impede implementation of an environmentally protective remedy, since CERCLA and the NCP already provide a procedural blueprint for responding to the release or threatened release of a hazardous substance into the environment. Only the substantive elements of other laws affect on-site responses.

Applicable requirements are those cleanup standards, controls, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, or contaminant, remedial action, location, or other circumstance at a Superfund site (40 CFR 300.400(g)). Basically, to be applicable, a requirement must directly and fully address a CERCLA activity. Determining which standards will be applicable to a Superfund response is similar to determining the applicability of any law or regulation to any chemical, action, or location. The identification of relevant and appropriate requirements is a two-step process; only those requirements that are considered both relevant and appropriate must be addressed at CERCLA sites. The EPA is ultimately responsible for deciding which requirements are both relevant and appropriate.

3.5.2 State and Local ARARs

Many states implement environmental regulations that differ from federal standards. CERCLA Section 121(d)(2) requires compliance with applicable or relevant and appropriate state requirements when they are more stringent than federal rules and have been "promulgated" at the state level. To be viewed as promulgated and serve as an ARAR at a Superfund site, a state requirement must be legally enforceable, based on specific enforcement provisions or the state's general legal authority, and must be generally applicable, meaning that it applies to a broader universe than Superfund sites. State rules must also be identified by the state in a timely manner (i.e., soon enough to be considered at the appropriate stage of the Superfund response process) in order to function as ARARs. Generally, laws and regulations adopted at the state level, as opposed to the regional, county, or local level, are potential state ARARs. Requirements that are developed by a local or regional body and are both promulgated and legally enforceable by the state may, however, also serve as ARARs. State ARARs may be waived under certain circumstances. Of the six waivers set forth in CERCLA Section 121(d)(4), one applies exclusively to state ARARs: the inconsistent application of a state standard waiver. In addition, many state regulations have their own waivers or exceptions that may be invoked at a Superfund site.

3.5.3 To-Be-Considered Guidelines and Other Controls

Conditions vary widely from site to site, thus ARARs alone may not adequately protect human health and the environment. When ARARs are not fully protective, the lead agent may implement other federal or state policies, guidelines, or proposed rules capable of reducing the risks posed by a site. Such TBC guidelines, while not legally binding (since they have not been promulgated), may be used in conjunction with ARARs to achieve an acceptable level of risk. When ARARs are non-existent (or may not be protective), TBCs were evaluated as part of the RI to set protective cleanup levels and goals. Proposed concentration-based action levels under RCRA could, for instance, be used as TBC guidelines to trigger treatment of soils contaminated with hazardous wastes. Because TBCs are not potential ARARs, their identification is not mandatory.

3.5.4 Identification of Potential ARARs

ARAR identification is a critical element of the Superfund response process that depends upon cooperation and communication among the EPA and VADEQ project offices. The ARAR identification process begins during the scoping phase of the FFS, and continues through the creation of the Record of Decision. During the scoping of this FFS and site characterization the following steps were completed for the ARARs and TBC item identification:

- Development of a list of all chemicals present and location characteristics,
- Identify potential chemical- and location-specific ARARs and TBCs, and
- Determine applicability and relevance and appropriateness of potential chemical- and location- specific ARARs.

Chemical- location-, and action-specific ARARs were identified. Reference Attachment 6. The VADEQ provided USACE a list of federal and state statues and regulations that potentially apply to the Greenwood Chemical site. The federal and state statutes and regulations that directly govern response activities are summarized in Tables 3-2 through 3-4, and were developed from VADEQ's list.

In accordance with 40 CFR 300.400(g) and 40 CFR 300.515, potential state ARARs were identified by VA DEQ in a letter to the EPA dated 10 January 2000. Most of the items identified by VADEQ were potential location-specific ARARs. The actions recommended in the state's letter were accomplished to determine the degree to which state agencies and local authorities potentially regulated the site, action(s), or chemicals of interest.

3.6 SUMMARY

The RI performed by Ebasco (1990) identified 19 COCs in soil at OU4. Preliminary remediation goals in on-site soil for these 19 COCs were developed to be protective of direct contact with surface soil and to be protective of off-site groundwater. The receptor scenario for the direct contact exposure pathway was recreational. The receptor for the off-site groundwater scenario was a residential consumption. The on-site direct contact goals for the surface soil were developed by EPA Region III (EPA, 1999; 2000). The on-site protection of off-site groundwater goals were developed first with a vadose zone-to-groundwater model and then refined through soil leachate testing. Table 3-5 presents the final set of concentration-based remediation goals.

Furthermore, preliminary ARARs were identified to determine how they would impact remedy selection. There are no federal chemical- or location-specific ARARs for soil; however, there are some potential ARARs for the possible remedial alternatives.

4.0 EXTENT OF CONTAMINATION IN VADOSE ZONE SOILS

The results of the extent of contamination evaluation are presented in this section. Nature of the contaminants at the site, their fate and transport, human and environmental risk have been addressed in Remedial Investigation (RI). Based on the RI, 19 COCs were identified for the site. The COCs are 1,2-Dichloroethane, 2,4,6-Trichlorophenol, 4-Chloroanaline, Acetone, Arsenic, Benzene, Bis(2-ethylhexyl)phthalate, Chlorobenzene, Chloroform, Dibutyl phthalate, Cyanide, Methylene Chloride, Naphthalene, Naphthalene Acetic Acid, Tetrachloroethylene, Tetrahydrofuran, Toluene, Trichloroethylene, and Xylenes.

4.1 EVALUATION AND LIMITATIONS OF THE DATA SET

The first step in the evaluation process was to compile a database of all the soil sampling data collected over the lifetime of the project. The existing analytical data for the site was entered into a GIS database created for the Greenwood Chemical Superfund Project. The purpose of the database is to maintain all analytical soil data in one central location that allows for ease of access and provides a mechanism for multiple outputs.

There are limitations inherent to assembling a database from historic information. The historic data for the Greenwood Chemical Superfund Site spans many years, there are no electronic files, and often the original laboratory documentation is missing. The data limitations must be recognized as imposing uncertainty on interpretations made from the data set. The primary uncertainty with respect to the database assembled for this project was that there were very few cases where the original laboratory data package was available. Most often, analytical information was in the form of summary tables inserted into documents. There were isolated cases where similar summary tables were in different documents and there was a discrepancy between the tables. Additionally, very few of the summary tables contained data qualifiers, and dates were missing from some of the tables. In all cases where a discrepancy arose, best professional judgment was used. The decisions made regarding discrepancies in the data are documented in Attachment 7, Database Assumptions.

4.2 POST REMEDIAL INVESTIGATION SAMPLING

Additional sampling collection efforts were made in 1997 and 2000 to collected data to support the selection of a remedial alternative. These efforts are discussed in the following sections.

4.2.1 Supplemental Data Collected in 1997

Once the database was established, the data was evaluated to determine if there were any significant data gaps with respect to evaluating contamination impacting the vadose zone soils. Several data gaps were identified in the manufacturing and drum disposal area, and a limited sampling event was performed in 1997 by the Baltimore District, USACE to address those gaps. The data collected from that sampling event was added to the project database. A short summary report documenting the supplemental sampling event is provided in Attachment 2.

4.2.2 Sampling in Northern Warehouse Area

In 1997, the GeoEnvironmental Engineering (GeoE) Branch of the Norfolk District USACE conducted a limited field investigation of the subsurface soils to confirm the presence or absence of acetone and arsenic contamination in the Northern Warehouse Area. During this sampling event, nineteen soil samples from seven, shallow soil borings were sampled in the vicinity of the Northern Warehouse. The purpose of this sampling was to determine if arsenic or acetone had impacted the shallow soils surrounding the Northern Warehouse. Reference Attachment 8, Northern Warehouse Sample Results. The highest surface soil (0-2 feet) concentration for arsenic was 3.5 ppm. This was well below the surface soil, risk-based PRG of 37 ppm. Overall, the highest level for arsenic was 55.6 ppm, collected from 4-6 feet below grade. This was well below the deep soils, groundwater-based PRG of 400 ppm. All samples analyzed for acetone were below detection limits. Based on these results, the Northern Warehouse has been excluded from further consideration.

4.2.3 Site Sampling November 2000

Supplemental sampling was performed in the fall of 2000 to gather the additional data necessary to develop OU-4 remedial alternatives. Samples were collected from the surface and subsurface soils. Surface soils were collected at background locations to determine the range of naturally occurring inorganic chemicals. Subsurface samples were collected to examine the ability of subsurface soil contamination to leach through the vadose zone and contaminate the groundwater.

Leaching was examine with the Synthetic Precipitation Leaching Procedure (SPLP). Results of the extraction process were used to determine a COCs potential to adversely impact the groundwater. In order to perform the comparison, samples with varying concentrations of site COC were required; therefore, additional sampling was required in areas of known contamination. Sampling results are presented in Attachment 9.

The formulation of PRGs based on the SPLP and background analysis was discussed in detail in Section 3.0. For the purpose of the extent of contamination evaluation, Table 4-1 lists the COCs, their respective PRG and the maximum concentration detected on-site. Surface soil, risk-based PRGs were determined only for the two inorganic COCs, arsenic and cyanide.

4.3 Extent of Contamination Evaluation

Once PRGs were established, an evaluation was performed to estimate the extent of contamination above PRGs. For the purpose of the extent of contamination evaluation discussion, the site has been divided into two areas, the manufacturing area, and the drum disposal area. The manufacturing area includes former processing buildings A, B and C, the former lagoon known as backfill northeast, the 935 square, backfill north, and former lagoons 1, 2 and 3. The drum disposal area consisted of a series of trenches located along the western boundary of the site. See Figure 1-3 for site features.

Prior to performing the extent of contamination evaluation, all data from within the OU-1 excavation boundaries (e.g. soils removed during the OU-1 remedial action) were excluded from the data set. Once the sampling points from previously remediated areas had been excluded, each COC was compared against its respective PRG. Six COCs, 1,2-Dichloroethane, Acetone, Chloroform, Dibutyl phthalate, Naphthalene Acetic Acid, and Xylene had no data points above their respective PRGs. One COC, 2,4,6-Trichlorophenol, had no data points that exceeded the detection limit. Two COCs, Trichloroehtylene and Tetrahydrofuran had data points above their PRGs only in the manufacturing area, not the drum disposal area. And one COC, naphthalene, had data points above its PRG only in the drum disposal area. Table 4-1 list the maximum contaminant level detected for each COC and highlights COCs that exceeded PRGs.

4.3.1 Evaluation Tools

An extent of soil contamination evaluation was performed using the 3-D Scatter Point module within the program titled "The Department of Defense Groundwater Modeling System" (GMS), Version 3.1 (USACE, 2001). The GMS program is the graphical user interface portion of the GMS system that provides tools for site characterization, model conceptualization, mesh and grid generation, geostatistics, and post-processing. The 3-D Scatter Point module in GMS uses interpolation methods to create iso-surfaces from groups of 3D scatter points. Data is entered as an xyzc scatter point, where xyz is the location of the point the measurement is taken, and c is the concentration at that location. The data is bounded by a grid, and a mathematical algorithm is used to interpolate from actual sampling data points, to grid points. Iso-surfaces can then be created from the interpolated data, and the iso-surfaces can be used in various ways to visualize the extent of contamination. The interpolation method used for the evaluation of this data was Inverse Distance Weighted; Shepard's Method or Gradient Hyperplane Nodal Functions.

The extent of contamination surfaces generated in this fashion should be recognized as mathematical interpretations with limitations with respect to their representation of actual site conditions. However, these surfaces are adequate to estimate the approximate areal extent of contamination, and to estimate material volume quantities for evaluation of remedial alternatives.

The iso-surfaces created represent the area of soil contamination above the PRG. Figure 4-1 shows a composite of all organic COCs over their respective protection of groundwater PRGs. Figure 4-2 shows a composite of all inorganic COCs over their respective protection of groundwater PRGs. These composite organic and inorganic plume drawings were used to estimate the areas and volumes of impacted soils for use in screening and comparison of remedial alternatives. Individual plumes are included in Attachment 10. Excavation contours from the interim removal action are shown on the plume figures as a point of reference.

4.3.2 Contaminated Soil Volume Estimates

Volume estimates for soils that exceed protection of groundwater PRGs were calculated based on the following:

- Combined Organic & Inorganic Plumes- Manufacturing Area. Areal extent was determined by tracing the perimeter of the overlapped inorganic and organic plumes. Because approximately half of the combined inorganic and organic plume was located at an average depth of 30 feet (organic portion) and half was located at an average depth of 15 feet (inorganic portion), an average combined depth of 20 feet was selected for estimating volume in the manufacturing area.

- Combined Organic & Inorganic Plumes – Drum Disposal Area. Areal extent was determined by tracing the perimeter of the overlapped plumes. Because the inorganic plume was contained within the organics plume, an average depth of 30 feet was selected for estimating volume in the drum disposal area.

The volumes of soil exceeding PRGs estimated in this fashion are conservative given the assumption that the entire vertical thickness of the vadose zone is uniformly contaminated. It is likely that the actual soil volumes are considerably less, but this cannot be verified based on the degree of deep soil sampling conducted.

Three COCs, Chlorobenzene in the drum disposal area and Tetrahydrofuran and Toluene in the manufacturing area, had insufficient data points to create contaminant plumes. Since the occurrence of all three contaminants are within areas encompassed by other volatile and semi-volatile contamination, no separate graphical evaluation of these two COCs will be generated. Areas and volumes calculated for the organic and inorganic COCs above protection of groundwater PRGs are presented in Table 4-2.

Volumes calculated for inorganic COCs above surface soil, risk-based PRGs are presented in Table 4-3. Figure 4-3 shows the COCs above the surface soil, risk based PRGs. Volume estimates for soils that exceed surface soil, risk-based PRGs were calculated based on the following:

- Cyanide did not exceed the PRG in the manufacturing area, so the areal extent of the direct contact risk was based on the extent of arsenic above the surface soil, risk-based PRG. Volume was determined based on a depth of two feet.

- Upon inspection of Figure 4-3, it can be seen that no COCs exist in the drum disposal area above direct contact PRGs. However, contamination in this area lies along the property line. Soil sampling was not conducted on the adjacent property.

The volume provided in Table 4-3 represents assumed contamination on an 0.5-acre area adjacent to the site. Volume was determined based on a depth of 2 feet. This volume estimate represents a conservative approach to addressing potential contamination on the adjacent property.

The soil volume estimates in Tables 4-2 and 4-3 take into account areas within the plumes that have been previously excavated (during the OU-1 remedial action) and replaced with clean fill, as well as clean fill used for grading purposes. The volume of clean fill located within the manufacturing area is estimated to be 219,000 ft^3. The volume of clean fill located within the drum disposal trench area is estimated to be 74,000 ft^3. The amount of clean fill placed on top of contaminated soils in the manufacturing area following the construction of the groundwater treatment facility is estimated to be 6,500 ft^3. The extent of fill placement with respect to the contaminant plumes can be seen in Figure 4-4.

5.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

The identification and screening process began with the development of a list of possible technology types. Reference Table 5-1. A list of technology types and process options is found in the first two columns of Table 5-1. Gray-shaded remedial technologies were screened out during the technology type screening.

Technologies retained for further evaluation were protective of human health and the environment, in compliance with ARARs, and addressed the Remedial Action Objectives (RAOs) identified in Section 1. The only exception is the No Action technology, which was retained for baseline comparison purposes. The technologies retained were further refined by evaluating them against the criteria of effectiveness, reduction of COCs through treatment, implementability, and cost. These retained technologies and process options were then assembled to develop remedial action alternatives for OU-4. It is important to note that regardless of which remedial action alternatives are selected for OU-4, the long-term response action for groundwater will continue.

5.1 TECHNOLOGIES RETAINED

General response actions (GRAs) are actions that will satisfy the RAOs. Technologies retained were found to be acceptable GRAs based on the evaluation criteria. These technologies consisted of institutional controls in conjunction with the following: containment actions (permeable and impermeable caps) and excavation and off-site disposal actions. Brief descriptions of the GRAs are presented below.

5.1.1 Institutional Controls

This response action reduces exposure to contaminated media. Implementation of institutional controls is not considered a remedial action; therefore it is not listed in Table 5-1. Generally, this action is used in combination with remedial actions to prevent exposure to contaminants. However, this response action may be sufficient if human health and the environment is sufficiently protected. In addition, this action may be implemented as the only action in circumstances where active response actions such as treatment or excavation are not feasible. Institutional controls include access restrictions, provision of an alternate water supply, groundwater use restrictions, deed restriction, and monitoring of environmental media.

5.1.2 No Action

This response action indicates no activity will be performed to address the RAOs. The NCP requires this evaluation to provide a baseline for comparison with other developed alternatives. Current monitoring or implementation of controls or activities would be discontinued under this GRA.

5.1.3 Containment

This GRA minimizes migration of contamination from the source media, and/or eliminates direct contact to the media. Containment employs low-permeability material to reduce infiltration of precipitation, thereby mitigating contamination of the groundwater. Containment can also provide erosion control.

5.1.4 Excavation and Off-Site Disposal

This GRA addresses contaminated soil by removing it from the site. This response action would reduce the mass of contaminants that could potentially migrate from the source. Therefore, unacceptable risks associated with the contamination are removed from the site.

Excavation uses conventional earth moving equipment. Excavation would require the use of dust and erosion control procedures. Due to the depth of contamination and the level of the groundwater table, dewatering activities may be required at the site. Dewatering would require extraction of water from the excavation area, treatment, and appropriate disposal.

5.2 TECHNOLOGIES NOT RETAINED

The following technologies were screened out primarily because the soil properties at the site, such as low permeability and high clay content, make the large-scale application of these technologies difficult. Provided below is a brief description of these technologies.

5.2.1 In-Situ Treatment

In-situ treatment involves treating contaminated media in place, thereby, reducing the volume and/or mobility of the contaminants. Types of in-situ treatment technologies for soil that were evaluated include stabilization/solidification, soil flushing, vitrification, soil vapor extraction, and bioremediation. These technologies employ a variety of techniques to treat the contamination.

In-situ treatment actions are advantageous because they do not require removal of the waste for treatment. Therefore, additional risks to the workers and community are limited compared to ex-situ activities.

5.2.2 Ex-Situ Treatment

Ex-situ treatment requires the removal of contaminated media. Once the contaminated media is removed, it is treated and disposed of appropriately. The types of treatment are similar to in-situ treatment for soil and include soil washing, vitrification, dehalogenation, bioremediation, and incineration.

Ex-situ treatment is generally more costly than in-situ treatment because it requires that material be removed and treated. However, it can provide greater assurance that the PRGs are being achieved because confirmation sampling can be performed throughout the treatment process. In addition, ex-situ treatment can provide for lower off-site disposal costs, because treatment will not be required at the disposal facility.

6.0 DETAILED ANALYSIS OF ALTERNATIVES

The assembled remedial action alternatives represent a range of distinct waste management strategies that address the human health and environmental concerns associated with the site. Although the selected alternative will be further refined as necessary during the pre-design phase, the description of the alternatives and the analysis with respect to the nine criteria presented below, reflect the fundamental components of the various alternative hazardous waste management approaches being considered for this site.

6.1 EVALUATION CRITERIA

The detailed analysis will be performed using the nine evaluation criteria established by the NCP in 40 CFR 300.430(e)(9)(ii). Only the first seven criteria will be evaluated in this report. The last two criteria, State Acceptance and Community Acceptance will be evaluated after the state and community have reviewed the report and commented on the Proposed Plan.

The nine evaluation criteria are subdivided into three categories: Threshold Criteria, Primary Balancing Criteria, and Modifying Criteria. The requirements of each criterion are specified in the NCP. The categories and criteria are as follows:

<u>Threshold Criteria</u>: This category of criteria relates to statutory findings, therefore, the alternative selected for the remedial action must meet these criteria.

1. Overall protection of human health and the environment. Alternatives are assessed to determine whether they can provide adequate protection of human health and the environment. The adequacy of protection is evaluated in both the short- and long-term, from unacceptable risks posed by hazardous substances, pollutants, or contaminants present at the site. The criterion can be satisfied if the risks/exposures at the site are eliminated, reduced, or controlled to levels established during development of remediation goals. Overall protection of human health and the environment draws on the assessments of other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs.

2. Compliance with ARARs. The alternatives shall be assessed to determine whether they attain applicable or relevant and appropriate requirements under federal environmental laws and state environmental or facility siting laws or provide grounds for invoking one of the applicable waivers. The major federal and/or state requirements that are applicable or relevant and appropriate were identified in Section 3.0. The specific requirements that are applicable to each alternative are identified in this section. The ability of each alternative to meet all of its respective ARARs or the need to justify a waiver is noted for each.

Primary Balancing Criteria: This category is the primary criteria that the analysis of the alternatives is based on.

3. Long-term effectiveness and permanence. Long-term effectiveness and permanence are evaluated with respect to the magnitude of residual risk and the adequacy and reliability of controls used to manage the remaining waste (untreated waste and treatment residuals) over the long term. Alternatives that afford the highest degrees of long term effectiveness and permanence are those that leave little or no waste remaining at the site such that long-term maintenance and monitoring are unnecessary and reliance on institutional controls is minimized. Factors that were considered, as appropriate, include the following:

- Magnitude of residual risk remaining from untreated waste or treatment residuals remaining at the conclusion of the remedial activities. The characteristics of the residuals should be considered to the degree that they remain hazardous, taking into account their volume, toxicity, mobility, and propensity to bioaccumulate.

- Adequacy and reliability of controls such as containment systems and institutional controls that are necessary to manage treatment residuals and untreated waste. This factor addresses in particular the uncertainties associated with land disposal for providing long-term protection from residuals; the assessment of the potential need to replace technical components of the alternative, such as a cap, a slurry wall, or a treatment system; and the potential exposure pathways and risks posed should the remedial action need replacement.

4. Reduction of toxicity, mobility, or volume through treatment. The degree to which alternatives employ recycling or treatment that reduces toxicity, mobility, or volume was assessed, including how treatment is used to address the principal threats posed by the site. This evaluation relates to the statutory preference for selecting remedial action that employs treatment to reduce the toxicity, mobility, or volume of hazardous substances. Factors that shall be considered, as appropriate, include the following:

- The treatment or recycling processes the alternatives employ and materials they will treat;
- The amount of hazardous substances, pollutants, or contaminants that will be destroyed, treated, or recycled;
- The degree of expected reduction in toxicity, mobility, or volume of the waste due to treatment or recycling and the specification of which reduction(s) are occurring;
- The degree to which the treatment is irreversible;
- The type and quantity of residuals that will remain following treatment, considering the persistence, toxicity, mobility, and propensity to bioaccumulate of such hazardous substances and their constituents; and
- The degree to which treatment reduces the inherent hazards posed by principal threats at the site.

5. Short-term effectiveness. Evaluation of the alternatives with respect to short-term effectiveness takes into account protection of workers and community during the remedial action, environmental impacts from implementing the action, and the time required to achieve cleanup goals. The short-term impacts of alternatives shall be assessed considering the following:

- Short-term risks that might be posed to the community during implementation of an alternative;
- Potential impacts on workers during remedial action and the effectiveness and reliability of protective measures;
- Potential environmental impacts of the remedial action and the effectiveness and reliability of mitigative measures during implementation; and
- Time until protection is achieved.

6. Implementability. The analysis of implementability deals with the technical and administrative feasibility of implementing the alternatives as well as the availability of necessary goods and services. The ease or difficulty of implementing the alternatives was assessed by considering the following types of factors as appropriate:

- Technical feasibility, including technical difficulties and unknowns associated with the construction and operation of a technology, the reliability of the technology, ease of undertaking additional remedial actions, and the ability to monitor the effectiveness of the remedy.
- Administrative feasibility, including activities needed to coordinate with other offices and agencies and the ability and time required to obtain any necessary approvals and permits from other agencies (for off-site actions);
- Availability of services and materials, including the availability of adequate off-site treatment, storage capacity, and disposal capacity and services; the availability of necessary equipment and specialists, and provisions to ensure any necessary additional resources; the availability of services and materials; and availability of prospective technologies

7. Cost. The cost estimates presented in this report are programming level and order of magnitude estimates. These costs are based on a variety of information including vendor information, conventional cost estimating guides (e.g., Remedial Action Cost Engineering and Requirements System (RACER)), and prior experience. The Feasibility Study level cost estimates used in this FFS were prepared in accordance with the information available at the time of the estimate. The actual costs of the project will depend on true labor and material costs, actual site conditions, competitive market conditions, final project scope, the implementation schedule, and other variable factors. A significant uncertainty that would affect the cost is the actual volumes of contaminated soil. Most of these uncertainties would affect all of the costs presented in the FFS similarly. The types of costs that shall be assessed include the following:

- Capital costs, including both direct and indirect costs: Capital costs include those expenditures required to implement a remedial action. Both direct and indirect costs are considered in the development of capital cost estimates. Direct costs include construction costs for equipment, labor, and materials required to implement the remedial action. Indirect costs include those associated with engineering, permitting, construction management, and other services necessary to carry out a remedial action.
- Annual operation and maintenance costs: Annual operations and maintenance costs, which include operation labor, maintenance manuals, energy, and purchased services have also been determined. The estimates include those operation and maintenance (O&M) costs that may be incurred even after the initial remedial activity is complete.
- Escalation Costs: Escalation costs represent the price adjacent from the current date to the date which work will be performed. The capital and O&M costs shown in Table 6-10 do not include escalation costs, and were developed from the 2001 RACER database. Reference Attachment 11, Cost Estimate to see detailed cost reports, which include escalation costs.

Modifying Criteria. The final two criteria are evaluated following comment on the FFS report and the proposed plan and are addressed during preparation of the decision document or Record of Decision (ROD).

8. State acceptance. Assessment of state concerns may not be completed until comments on the FFS are received but may be discussed, to the extent possible, in the proposed plan issued for public comment. The state concerns that shall be assessed include the following:

- The state's position and key concerns related to the preferred alternative and other alternatives; and
- State comments on ARARs or the proposed use of waivers.

9. Community acceptance. This assessment includes determining which components of the alternatives interested persons in the community support, have reservations about, or oppose. This assessment may not be completed until comments on the proposed plan are received.

The following sections provide the detailed analysis of the remedial action alternatives.

6.2 Description and Analysis of Alternatives

A technical description of the alternatives is presented. After the technical description, the evaluation of the alternative with respect to overall protection of human health and the environment; compliance with ARARs; long term effectiveness and permanence; reduction in toxicity, mobility, or volume through treatment; short term effectiveness; implementability; and cost is presented in Tables 6-1 through 6-8. Regardless of the remedial alternative selected (with the exception of complete excavation above PRGs) the OU-2 groundwater pump and treat system will be modified, as necessary, to ensure containment of groundwater contamination within the attainment area.

6.2.1 Drum Disposal Area & Manufacturing Area

The following two alternatives were evaluated for the entire area: 1) No Remedial Action & Institutional Controls, and 2) Impermeable Cap & Institutional Controls. Provided below is a detailed description and analysis of these two alternatives.

6.2.1.1 Alternative 1, Entire Site - No Remedial Action & Institutional Controls

The no remedial action alternative provides a baseline for comparing other alternatives. Because no remedial activities would be implemented with the no remedial action alternative, the remaining long-term human health and environmental risks for OU-4 would not change. However, the overall human health and environmental risks for the entire site have already been reduced as a result of the implementation of the remedies for OU-1 (removal of some sludge, soil, and chemical containers) and OU-2 (groundwater treatment system). In addition, use of institutional controls such as access restrictions, deed restrictions, and fencing would limit exposure to contaminated media.

The detailed analysis of the no remedial action & institutional controls alternative is presented in Table 6-1.

6.2.1.2 Alternative 2, Entire Site – Impermeable Cap & Institutional Controls

The impermeable cap alternative involves the construction of an impermeable cap over both the Manufacturing Area and the Drum Disposal Area. Though this site is not a landfill, design criteria for RCRA Subtitle C caps should be considered during the construction of this cap. A 7-acre impermeable cap, as utilized in the cost estimate, would cover the area impacted by both organic and inorganic contaminated soils, as well as the surrounding soils including the adjacent property. There are currently no known COCs on the property adjacent to the drum disposal area; however, this area was included in the cost analysis to account for potential contamination. An impermeable cap would reduce, if not eliminate, the infiltration of water through the soil column, thus mitigating the effect of contaminant transport to the groundwater. In addition, use of institutional controls such as access restrictions, deed restrictions, and fencing would limit exposure to contaminated media.

Reducing the infiltration of water may have an effect on the existing groundwater pump and treat. According to the U.S. Department of Agriculture (USDA) hydrologic soil map, soils in the area are known as Porters Stoney Loam, which are classified as Type B soils. Infiltration rate ranges from 0.15 – 0.30 in/hr for Type B soils. Assuming an impermeable cap of 7-acres, for any given rainfall event, the maximum reduction in recharge to the groundwater extraction wells would be 2.1 ft^3/sec (0.30 in/hr x 7 acres = 2.1 in-acre/hr or ft^3/sec). However, if an actual percolation test were conducted at the site, it may be found that the infiltration rate is much less than what is the norm for Type B soils. This is based on the particle size distribution test reports, which showed that the clay content in the soil typically ranged from 20-30 % clay.

The detailed analysis of the impermeable cap & institutional controls is presented in Table 6-2.

6.2.2 Manufacturing Area

The following three alternatives were evaluated for the manufacturing area: 1) Excavation & Institutional Controls, 2) Permeable Cap & Institutional Controls, and 3) Impermeable Cap & Institutional Controls. Provided below is a detailed description and analysis of these three alternatives.

6.2.2.1 Alternative 1, Manufacturing Area - Excavation & Institutional Controls

The components of the excavation and off-site disposal alternative are:

- Excavation and segregation of all COC impacted soil that exceed the clean-up levels established in the PRGs,
- Segregation of clean soil and reuse as backfill,
- Restoration of the excavated area,
- Transportation of all selected soils to an off-site transportation, storage and disposal facility (TSDF),
- Treatment/disposal at a selected TSDF, and
- Use of institutional controls such as access restrictions, deed restrictions, and fencing.

For this alternative, the Land Disposal Restrictions (Title 40, Part 268), Hazardous Waste Identification (40 CFR 261, manifesting 262 etc.), and Department of Transportation Hazardous Materials Regulations (49 CFR 172 - 178) would potentially apply.

The excavation cost estimate was based on the volume estimate presented in Table 4-2. Based on this volume, a 1: 0.75 (V:H) benching of the excavation was assumed in RACER. The detailed analysis of the excavation and off-site disposal alternative is presented in Table 6-3.

6.2.2.2 Alternative 2, Manufacturing Area – Permeable Cap & Institutional Controls

The permeable cap alternative involves the removal of the top 0-2 feet of COC contaminated soil above the direct contact PRGs, backfilling with clean soil, and grading to achieve an acceptable slope. Though this site is not a landfill, design criteria employed for RCRA Subtitle D caps should be considered during the construction of this cap. Eliminating the direct contact risk would be the primary benefit of this permeable cap, as well as removal of "hot spot" inorganic contaminated soil. Inorganic contamination is typically higher near the surface. In addition, use of institutional controls such as access restrictions, deed restrictions, and fencing would limit exposure to contaminated media.

The excavation cost estimate was based on the volume estimate presented in Table 4-3. The detailed analysis of the permeable cap alternative is presented in Table 6-4.

6.2.2.3 Alternative 3, Manufacturing Area – Impermeable Cap & Institutional Controls

The permeable cap alternative involves the construction of an impermeable cap over the Manufacturing Area. Though this site is not a landfill, design criteria employed for RCRA Subtitle C caps should be considered during the construction of this cap. A 5.5-acre impermeable cap, as utilized in the cost estimate, would cover the area impacted by both organic and inorganic COCs soils, as well as the surrounding soils. An impermeable cap would reduce, if not eliminate, the infiltration of water through the soil column, thus mitigating the effect of contaminant transport to the groundwater. In addition, use of institutional controls such as access restrictions, deed restrictions, and fencing would limit exposure to contaminated media.

As mentioned previously, soils in this area are classified as Type B soils. Infiltration rate ranges from 0.15 – 0.30 in/hr for Type B soils. Assuming an impermeable cap of 5.5-acres, for any given rainfall event, the maximum reduction in recharge to the groundwater extraction wells would be 1.7 ft^3/sec (0.30 in/hr x 5.5 acres = 1.7 in-acre/hr or ft^3/sec). However, if an actual percolation test were conducted at the site, it may be found that the infiltration rate is much less than what is the norm for Type B soils. This is based on the particle size distribution test reports, which showed that the clay content in the soil typically ranged from 20-30 % clay.

The detailed analysis of the impermeable cap alternative is presented in Table 6-5.

6.2.3 Drum Disposal Area

The following three alternatives were evaluated for the drum disposal area: 1) Excavation & Institutional Controls, 2) Permeable Cap & Institutional Controls, and 3) Impermeable Cap & Institutional Controls. Provided below is a detailed description and analysis of these three alternatives.

6.2.3.1 Alternative 1, Drum Disposal Area – Excavation & Institutional Controls

The components of the excavation and off-site disposal alternative are:

- Excavation and segregation of all COC impacted soil that exceed the clean-up levels established in the PRGs,
- Segregation of clean soil and reusing as backfill,
- Restoration of the excavated area,
- Transportation of all selected soils to an off-site TSDF, and
- Treatment/disposal at a selected TSDF, and

- Use of institutional controls such as access restrictions, deed restrictions, and fencing.

For this alternative, the Land Disposal Restrictions (Title 40, Part 268), Hazardous Waste Identification (40 CFR 261, manifesting 262 etc.), and Department of Transportation Hazardous Materials Regulations (49 CFR 172 - 178) would potentially apply.

The excavation cost estimate was based on the volume estimate presented in Table 4-2. Based on this volume, a 1: 0.75 (V:H) benching of the excavation was assumed in RACER. The detailed analysis of the excavation and off-site disposal alternative is presented in Table 6-6.

6.2.3.2 Alternative 2, Drum Disposal Area – Permeable Cap & Institutional Controls

The permeable cap alternative involves the removal of the top 0-2 feet of COC contaminated soil above the direct contact PRGs, backfilling with clean soil, and grading to achieve an acceptable slope. Though this site is not a landfill, design criteria employed for RCRA Subtitle D caps should be considered during the construction of this cap. Eliminating the direct contact risk would be the primary benefit of this permeable cap, as well as removal of "hot spot" inorganic contaminated soil. Inorganic contamination is typically higher near the surface. In addition, use of institutional controls such as access restrictions, deed restrictions, and fencing would limit exposure to contaminated media.

The excavation cost estimate was based on the volume estimate presented in Table 4-3. Reference Figure 4-3. Based upon the sampling conducted to date, there are no known COCs that exist above direct contact in the Drum Disposal Area. This volume was derived by assuming that approximately 0.5-acres on the adjacent property contained COCs above direct contact in the 0-2 foot depth.

The detailed analysis of the permeable cap alternative is presented in Table 6-7.

6.2.3.3 Alternative 3, Drum Disposal Area – Impermeable Cap & Institutional Controls

The impermeable cap alternative involves the construction of an impermeable cap over the Drum Disposal Area. Though this site is not a landfill, design criteria for RCRA Subtitle C caps should be considered during the construction of this cap. A 1.5-acre impermeable cap, as utilized in the cost estimate, would cover the area impacted by both organic and inorganic contaminated soils, as well as the surrounding soils including the adjacent property. There are currently no known COCs on the property adjacent to the drum disposal area; however, this area was included in the cost analysis to account for potential contamination. An impermeable cap would reduce, if not eliminate, the infiltration of water through the soil column, thus mitigating the effect of contaminant transport to the groundwater. In addition, use of institutional controls such as access restrictions, deed restrictions, and fencing would limit exposure to contaminated media.

As mentioned previously in Section 6.2.1.2, soils in this area are classified as Type B soils. Infiltration rate ranges from 0.15 – 0.30 in/hr for Type B soils. Assuming an impermeable cap of 1.5-acres, for any given rainfall event, the maximum reduction in recharge to the groundwater extraction wells would be 0.50 ft^3/sec (0.30 in/hr x 1.5 acres = 0.50 in-acre/hr or ft^3/sec). However, if an actual percolation test were conducted at the site, it may be found that the infiltration rate is much less than what is the norm for Type B soils. This is based on the particle size distribution test reports, which showed that the clay content in the soil typically ranged from 20-30 % clay.

The detailed analysis of the impermeable cap alternative is presented in Table 6-8.

6.3 Comparative Analysis

In the following analysis, the alternatives are evaluated in relation to one another for each of the seven evaluation criteria. State and community acceptance will be addressed in the ROD following comments on the RI/FS report and the proposed plan. The purpose of this analysis is to identify relative advantages and disadvantages of each alternative. This analysis is summarized in Table 6-9.

6.3.1 Overall Protection of Human Health and the Environment

Assuming the continued operation of the groundwater pump and treat system, with the exception of the no remedial action alternative, all alternatives received an overall positive rating for protection of human health and the environment. Risk through direct contact with arsenic and cyanide contaminated soils is addressed in each alternative through the use of excavation and off-site disposal or capping. Mass transport of COCs from the soil to the groundwater is reduced only in the impermeable capping and excavation alternatives.

6.3.2 Compliance with ARARs

All of the alternatives, with the exception of the no remedial action alternative, received an overall positive rating for being in compliance with applicable or relevant and appropriate requirements (ARARs). There are three types of ARARs: chemical-specific, action-specific and location-specific. Chemical-specific ARARs were not developed for this site. The PRGs used in this FFS were developed based on a risk analysis for this site, and are not derived from promulgated regulations or published guidance, as required for chemical-specific ARARs. Therefore, chemical-specific ARARs are not applicable. The following is a brief analysis of the action- and location- specific ARARs:

- Action-Specific ARARs: Each of the alternatives, excluding the no remedial action alternative, involved some land disturbance activities. Land disturbance involves grading and excavation, which may generate fugitive dust emissions and promote erosion. Maintaining acceptable moisture content during construction activities easily controls dust emissions. Storm water management and sediment controls would be implemented during excavation activities to prevent erosion.

- Location-Specific ARARs: The site is located in the primary drinking water supply watershed. For the excavation alternatives, the soils above PRGs would be excavated and disposed off-site, thereby protecting the off-site groundwater. Impermeable capping alternatives would restrict COCs from leaching into the groundwater. Permeable capping alternatives would not restrict COCs from leaching into the groundwater. Thus, the permeable capping alternatives would not meet the location-specific ARAR.

6.3.3 Long-term Effectiveness and Permanence

Assuming the continued operation of the groundwater pump and treat system, all alternatives afford long-term effectiveness and permanence except the no remedial action alternative. Without the pump and treat system, the permeable capping alternatives would not achieve long-term effectiveness.

6.3.4 Reduction of Toxicity, Mobility, and Volume through Treatment

The no remedial action and impermeable cap alternatives do not meet the criteria of reduction of toxicity, mobility, and volume through treatment. Reduction of COC mass is addressed in the permeable capping and excavation alternatives. Recall that the permeable capping option involves the excavation of shallow soil (0-2 feet) in locations where the PRGs are exceeded.

6.3.5 Short-term Effectiveness

All the alternatives have short-term effectiveness. The no remedial action, permeable cap, and impermeable cap alternatives are expected to have the greatest short-term effectiveness. These alternatives are superior to the excavation alternative because they minimize the exposure risk to the community, workers, and the environment during implementation. While the permeable cap alternatives have an excavation component, it is considerably smaller in extent than the excavation associated with complete excavation of soils above PRGs.

6.3.6 Implementability

All the alternatives can feasibly be implemented using commonly employed methods, equipment, materials, and personnel. Relative to the other alternatives, the impermeable capping and the no remedial action are administratively easier to implement because no impacted soil requires removal from the site.

6.3.7 Cost

Reference Table 6-10, Greenwood Chemical FFS Cost Estimates. Alternatives with a cost below 8 MILLION were given a positive (+) rating factor. This dollar amount (8 MILLION) was selected because, excluding excavation, all combinations of alternatives addressing both areas were less than this amount. The combined excavation alternatives (excavation of all COCs above PRGs for the entire site) exceeded this amount by a factor of 13. Excavation of the manufacturing area and drum disposal is approximately $78.30 and $27.36 MILLION, respectively. As previously mentioned, a detailed cost estimate is provided in Attachment 11.

6.3.8 State Acceptance

This issue will be addressed in the ROD following public comment on the FFS and Proposed Remedial Action Plan (PRAP).

6.3.9 Community Acceptance

This issue will be addressed in the ROD following public comment on the FFS and PRAP.

7.0 REFERENCES

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FIGURES

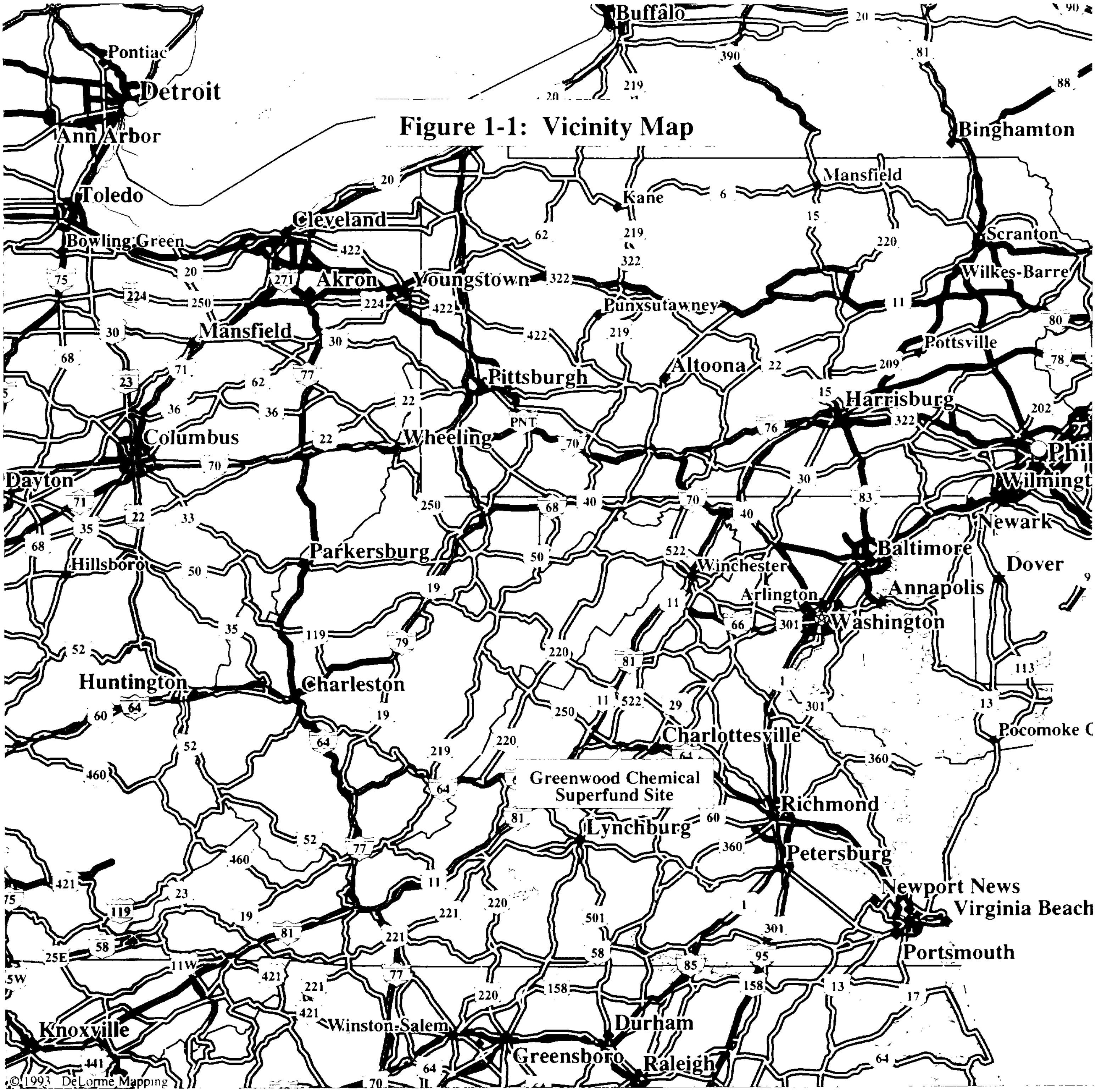

Figure 1-1: Vicinity Map

LEGEND

- Major City
- National Capitol
- State Capitol
- Town, Small City
- Large City
- Interstate, Turnpike
- US Highway
- State/Prov Boundary
- National Boundary
- Population Center
- Interstate Highway
- US Highway
- Land Mass
- Open Water

Scale 1:4,000,000 (at center)

50 Miles

100 KM

Mag 7.00

Tue Jan 15 09:05:00 2002

AR300896

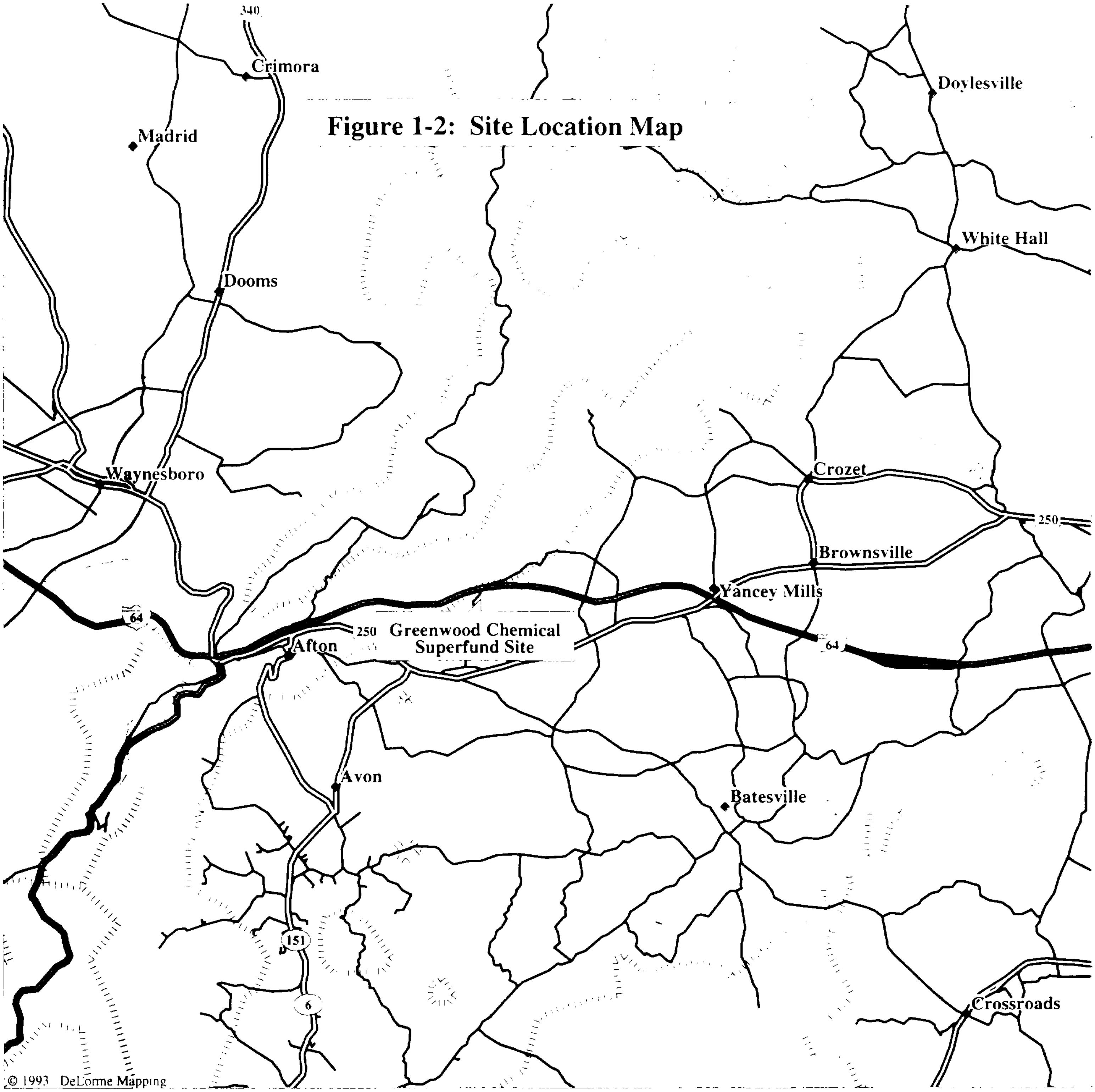

Figure 1-2: Site Location Map

LEGEND

- State Route
- Town, Small City
- Interstate, Turnpike
- US Highway
- County Boundary
- Population Center
- Major Street/Road
- Interstate Highway
- State Route
- US Highway
- Open Water
- Contours

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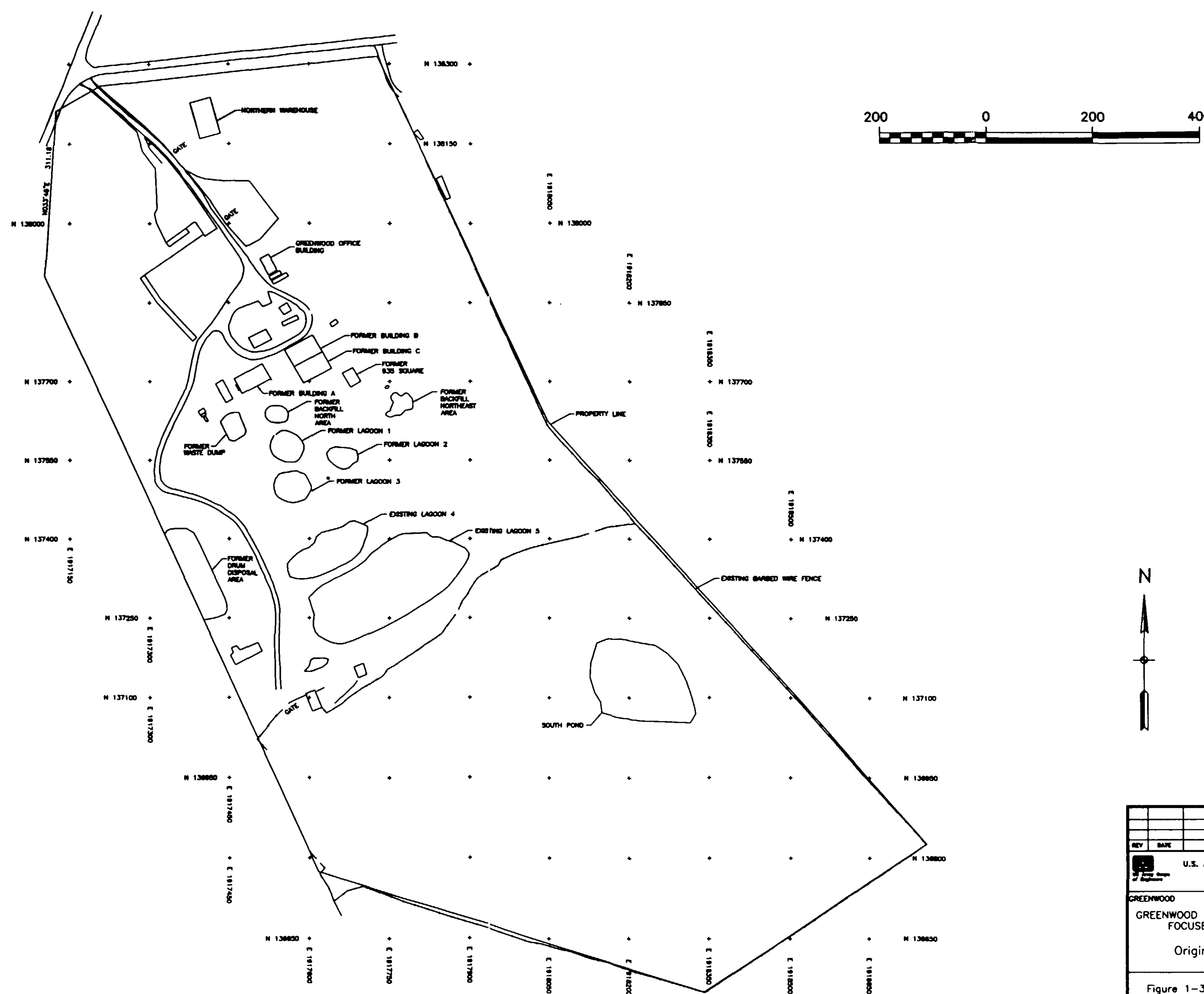

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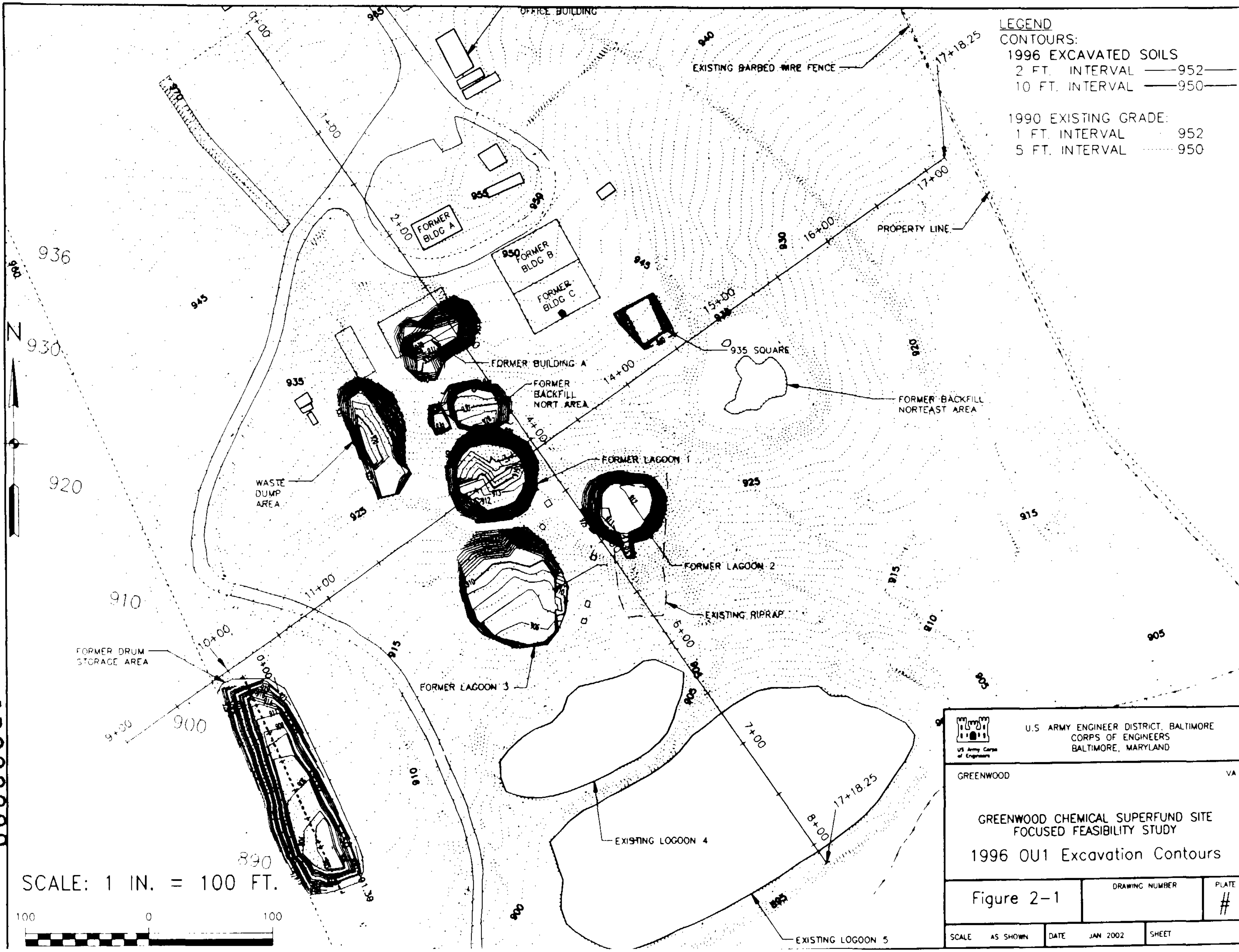
CORPS OF ENGINEERS
BALTIMORE, MARYLAND

GREENWOOD VIRGINIA

GREENWOOD CHEMICAL SUPERFUND SITE
FOCUSED FEASIBILITY STUDY

Original Site Features

Figure 1-3



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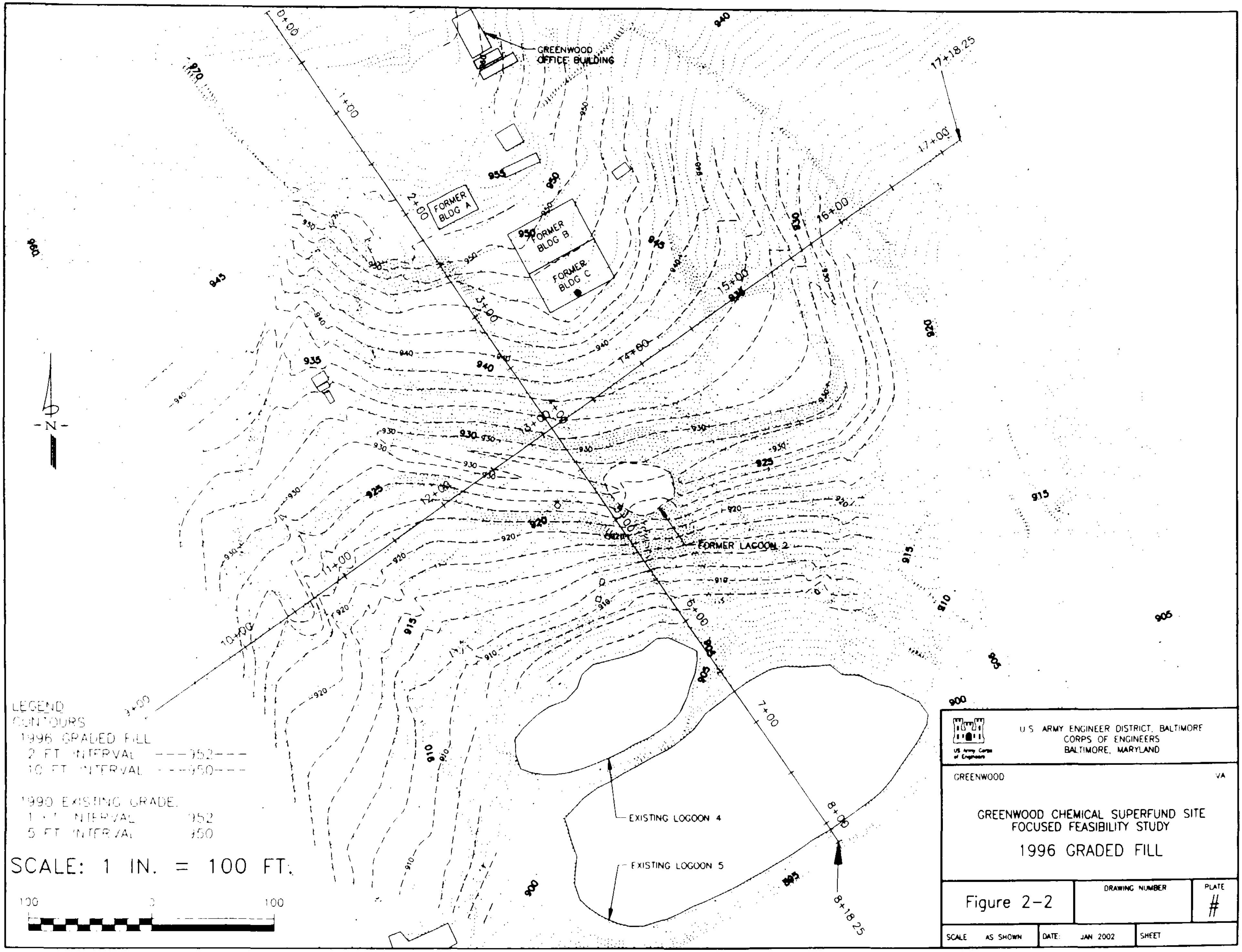
BALTIMORE, MARYLAND

GREENWOOD VA

GREENWOOD CHEMICAL SUPERFUND SITE
FOCUSED FEASIBILITY STUDY

1996 OU1 Excavation Contours

Figure 2–1	DRAWING NUMBER	PLATE #
SCALE AS SHOWN	DATE JAN 2002	SHEET



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BALTIMORE, MARYLAND

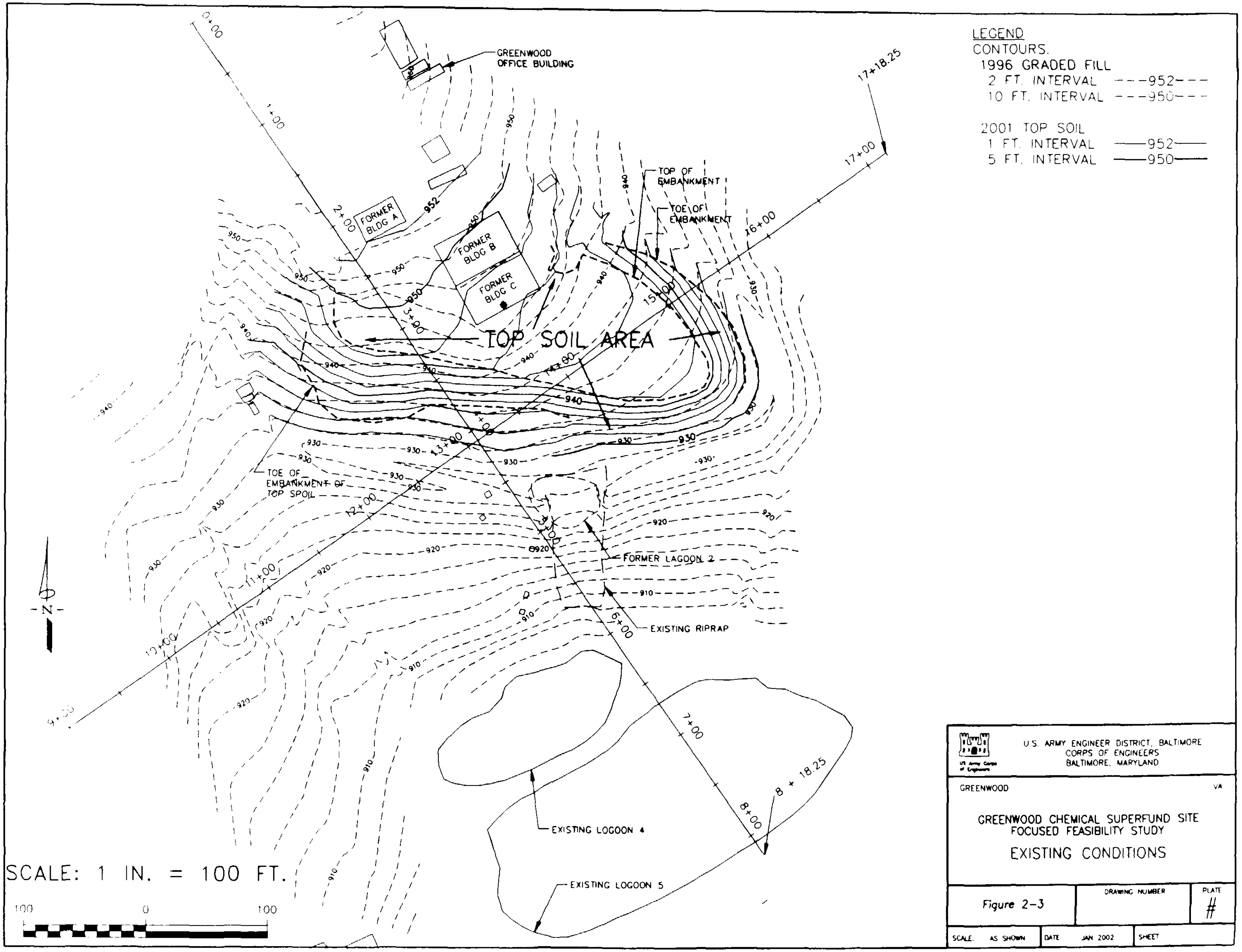
US Army Corps of Engineers

GREENWOOD VA

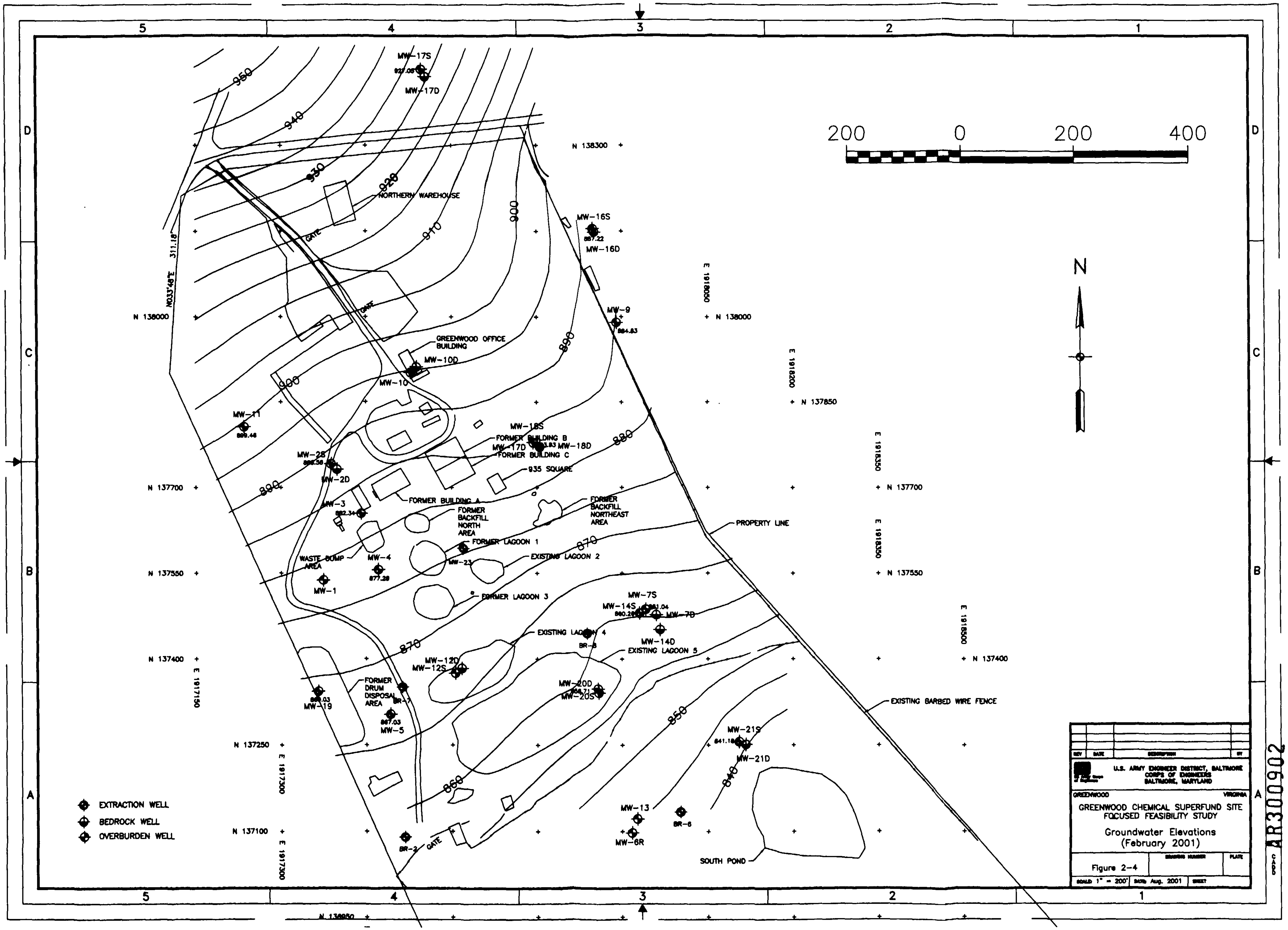
GREENWOOD CHEMICAL SUPERFUND SITE
FOCUSED FEASIBILITY STUDY

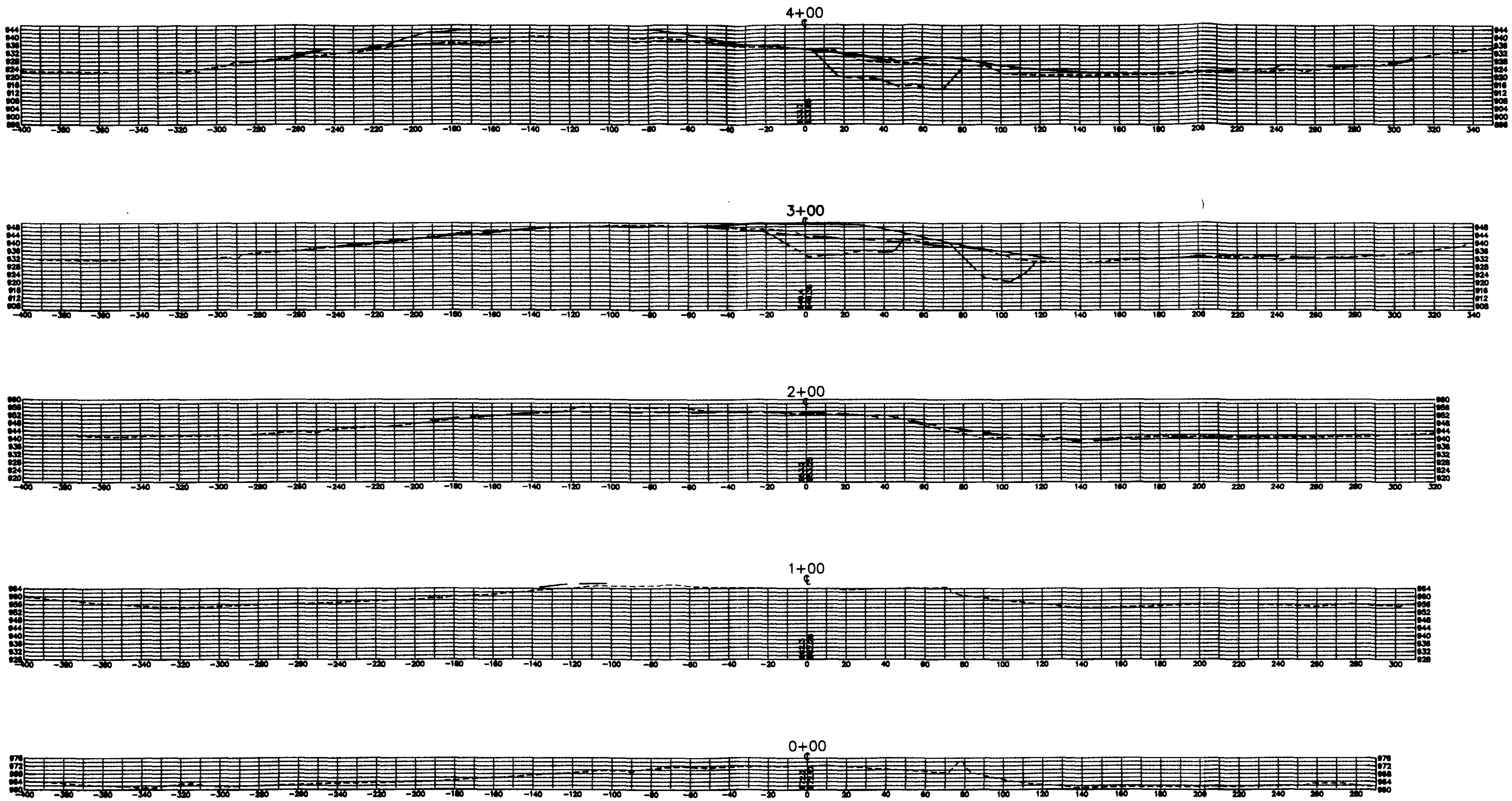
1996 GRADED FILL

Figure 2-2	DRAWING NUMBER	PLATE #
SCALE AS SHOWN	DATE: JAN 2002	SHEET


LEGEND
CONTOURS.
1996 GRADED FILL
2 FT. INTERVAL ---952---
10 FT. INTERVAL ---950---
2001 TOP SOIL
1 FT. INTERVAL ——952——
5 FT. INTERVAL ——950——
GREENWOOD OFFICE BUILDING
FORMER BLDG A
FORMER BLDG B
FORMER BLDG C
TOP OF EMBANKMENT
TOE OF EMBANKMENT
TOP SOIL AREA
TOE OF EMBANKMENT OF TOP SPOIL
FORMER LAGOON 2
EXISTING RIPRAP
EXISTING LOGOON 4
EXISTING LOGOON 5
17+18.25
8 + 18.25
SCALE: 1 IN. = 100 FT.
100 0 100
U.S. ARMY ENGINEER DISTRICT, BALTIMORE
CORPS OF ENGINEERS
BALTIMORE, MARYLAND
GREENWOOD
VA
GREENWOOD CHEMICAL SUPERFUND SITE
FOCUSED FEASIBILITY STUDY
EXISTING CONDITIONS
Figure 2-3
DRAWING NUMBER
PLATE
#
SCALE AS SHOWN
DATE JAN 2002
SHEET

AR300901


MW-17S
MW-17D
950
940
930
920
910
900
890
880
870
860
850
840
NORTHERN WAREHOUSE
GATE
N033°48'E 311.18'
N 138300
N 138000
N 137850
N 137700
N 137550
N 137400
N 137250
N 137100
E 1918050
E 1918200
E 1918350
E 1918500
E 1917150
E 1917300
MW-16S
887.22
MW-16D
MW-9
884.83
GREENWOOD OFFICE BUILDING
MW-10D
MW-10
MW-11
MW-18S
FORMER BUILDING B
MW-17D
MW-18D
FORMER BUILDING C
935 SQUARE
MW-2S
MW-2D
FORMER BUILDING A
MW-3
882.34
FORMER BACKFILL NORTH AREA
FORMER BACKFILL NORTHEAST AREA
PROPERTY LINE
FORMER LAGOON 1
EXISTING LAGOON 2
MW-23
WASTE DUMP AREA
MW-4
877.28
MW-1
FORMER LAGOON 3
MW-7S
MW-14S
MW-7D
MW-14D
EXISTING LAGOON 4
BR-8
EXISTING LAGOON 5
MW-12D
MW-12S
MW-20D
MW-20S
FORMER DRUM DISPOSAL AREA
BR-7
MW-19
867.03
MW-5
EXISTING BARBED WIRE FENCE
MW-21S
MW-21D
MW-13
BR-6
MW-6R
BR-2
GATE
SOUTH POND
EXTRACTION WELL
BEDROCK WELL
OVERBURDEN WELL
200 0 200 400
N
U.S. ARMY ENGINEER DISTRICT, BALTIMORE
CORPS OF ENGINEERS
BALTIMORE, MARYLAND
GREENWOOD
VIRGINIA
GREENWOOD CHEMICAL SUPERFUND SITE
FOCUSED FEASIBILITY STUDY
Groundwater Elevations
(February 2001)
Figure 2-4
1" = 200'
Aug. 2001



LEGEND

ORIGINAL GRADE

EXCAVATION GRADE

GRADED FILL GRADE

TOP SOIL GRADE

CROSS SECTION STATIONS 0+00 TO 4+00

SCALE: 1 IN.=50 FT.

50 0 50 100

U.S. ARMY ENGINEER DISTRICT, BALTIMORE
CORPS OF ENGINEERS
BALTIMORE, MARYLAND

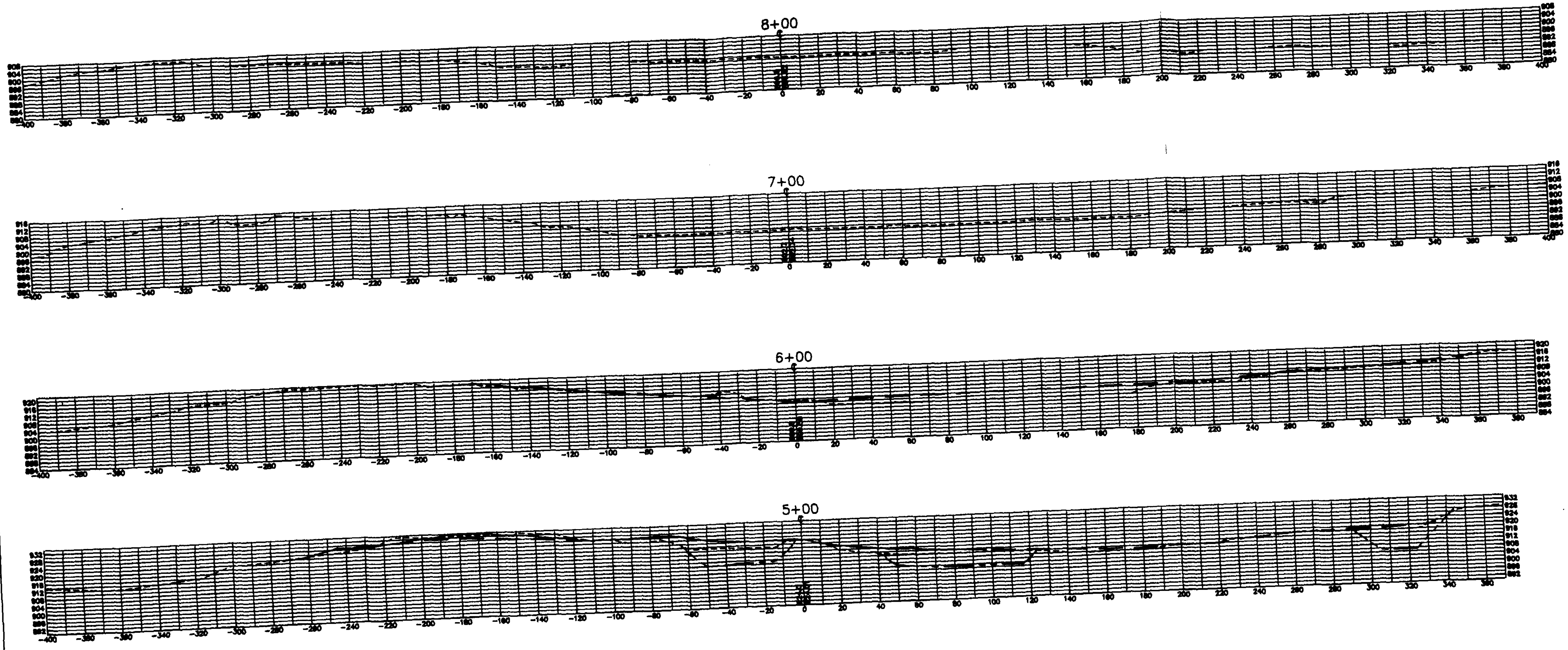
GREENWOOD VIRGINIA

GREENWOOD CHEMICAL SUPERFUND SITE
FOCUSED FEASIBILITY STUDY

Cross-Sections 0+00 to 4+00

	DRAWING NUMBER	PLATE
Figure 2-5		#

SCALE:	AS SHOWN	DATE:	JAN 2002	SHEET



CROSS SECTION STATIONS 5+00 TO 8+00

SCALE: 1 IN.=50 FT.

50 0 50 100

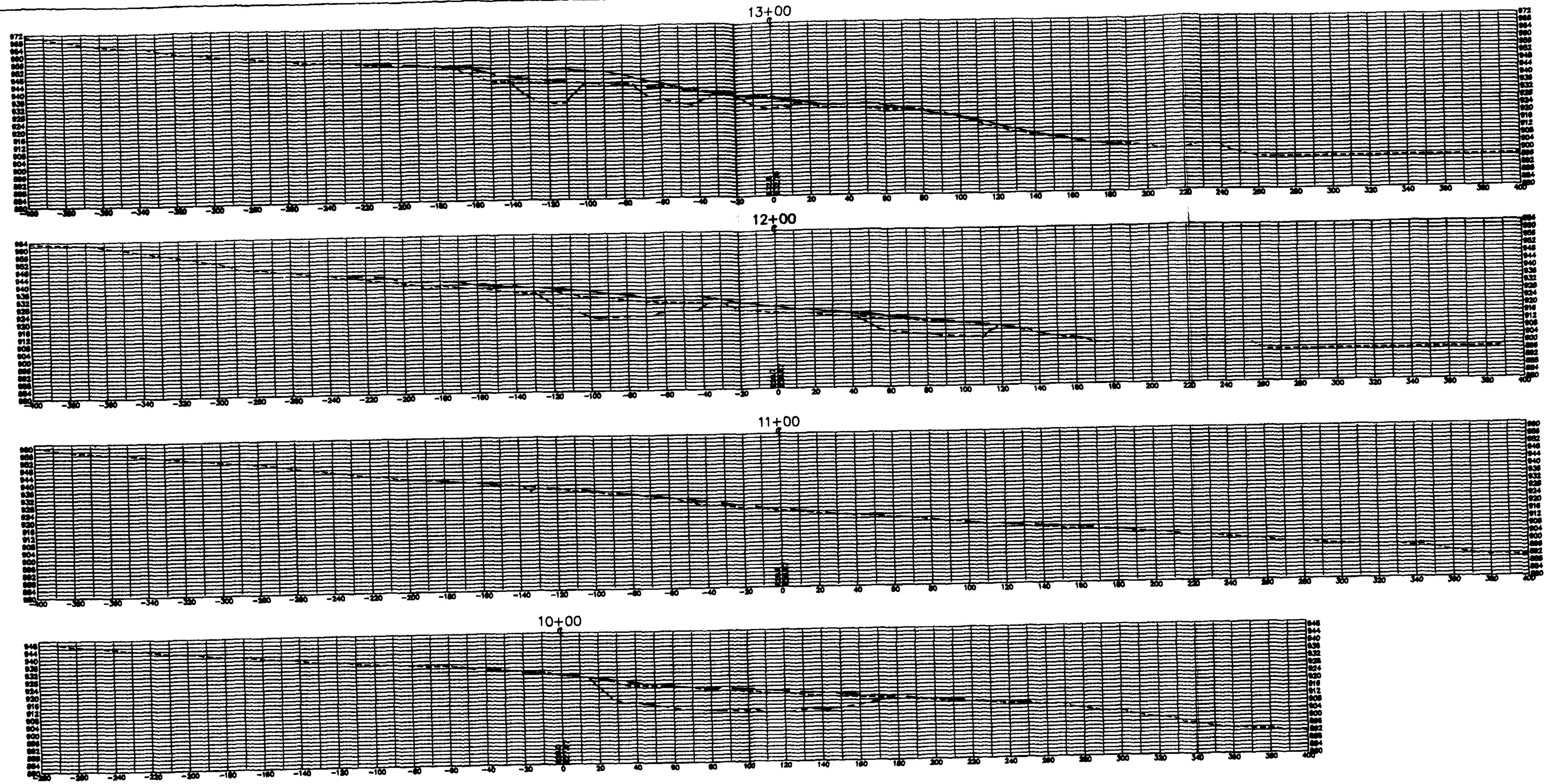
LEGEND

- ORIGINAL GRADE
- EXCAVATION GRADE
- GRADED FILL GRADE
- TOP SOIL GRADE

U.S. ARMY ENGINEER DISTRICT, BALTIMORE
CORPS OF ENGINEERS
BALTIMORE, MARYLAND

US Army Corps of Engineers

GREENWOOD	VIRGINIA
GREENWOOD CHEMICAL SUPERFUND SITE FOCUSED FEASIBILITY STUDY	
Cross–Sections 5+00 to 8+00	
DRAWING NUMBER: Figure 2–6	PLATE: #
SCALE: AS SHOWN	DATE: JAN 2002	SHEET



LEGEND

ORIGINAL GRADE

EXCAVATION GRADE

GRADED FILL GRADE

TOP SOIL GRADE

CROSS SECTION STATIONS 10+00 TO 13+00

SCALE: 1 IN.=50 FT.

50 0 50 100

US Army Corps of Engineers

U.S. ARMY ENGINEER DISTRICT, BALTIMORE
CORPS OF ENGINEERS
BALTIMORE, MARYLAND

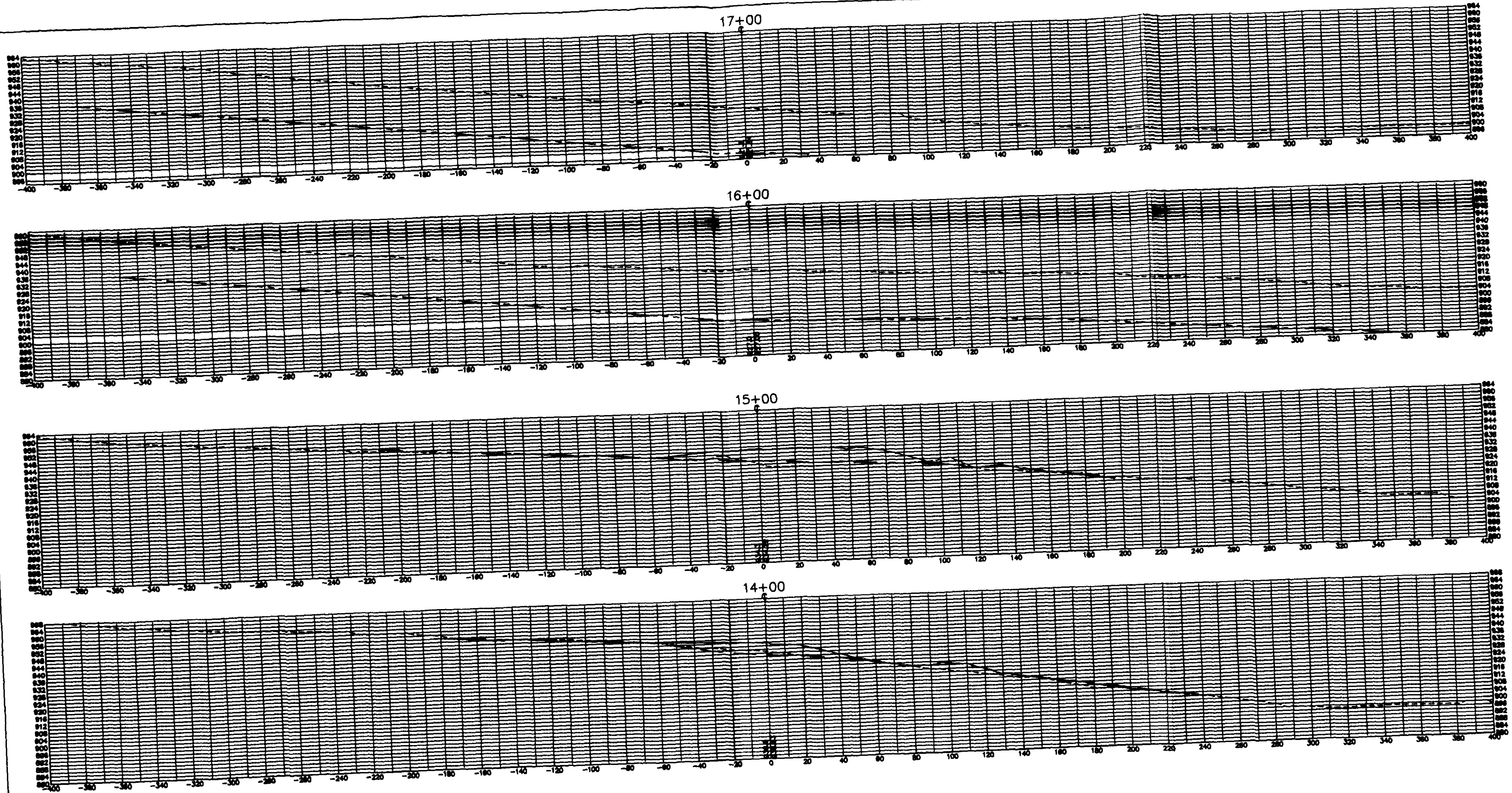
GREENWOOD VIRGINIA

GREENWOOD CHEMICAL SUPERFUND SITE
FOCUSED FEASIBILITY STUDY

Cross-Sections 10+00 to 13+00

	DRAWING NUMBER	PLATE
Figure 2-7		#

SCALE: AS SHOWN	DATE: JAN 2002	SHEET



CROSS SECTION STATIONS 14+00 TO 17+00

SCALE: 1 IN.=50 FT.

50 0 50 100

LEGEND

ORIGINAL GRADE

EXCAVATION GRADE

GRADED FILL GRADE

TOP SOIL GRADE

U.S. ARMY ENGINEER DISTRICT, BALTIMORE
CORPS OF ENGINEERS
BALTIMORE, MARYLAND

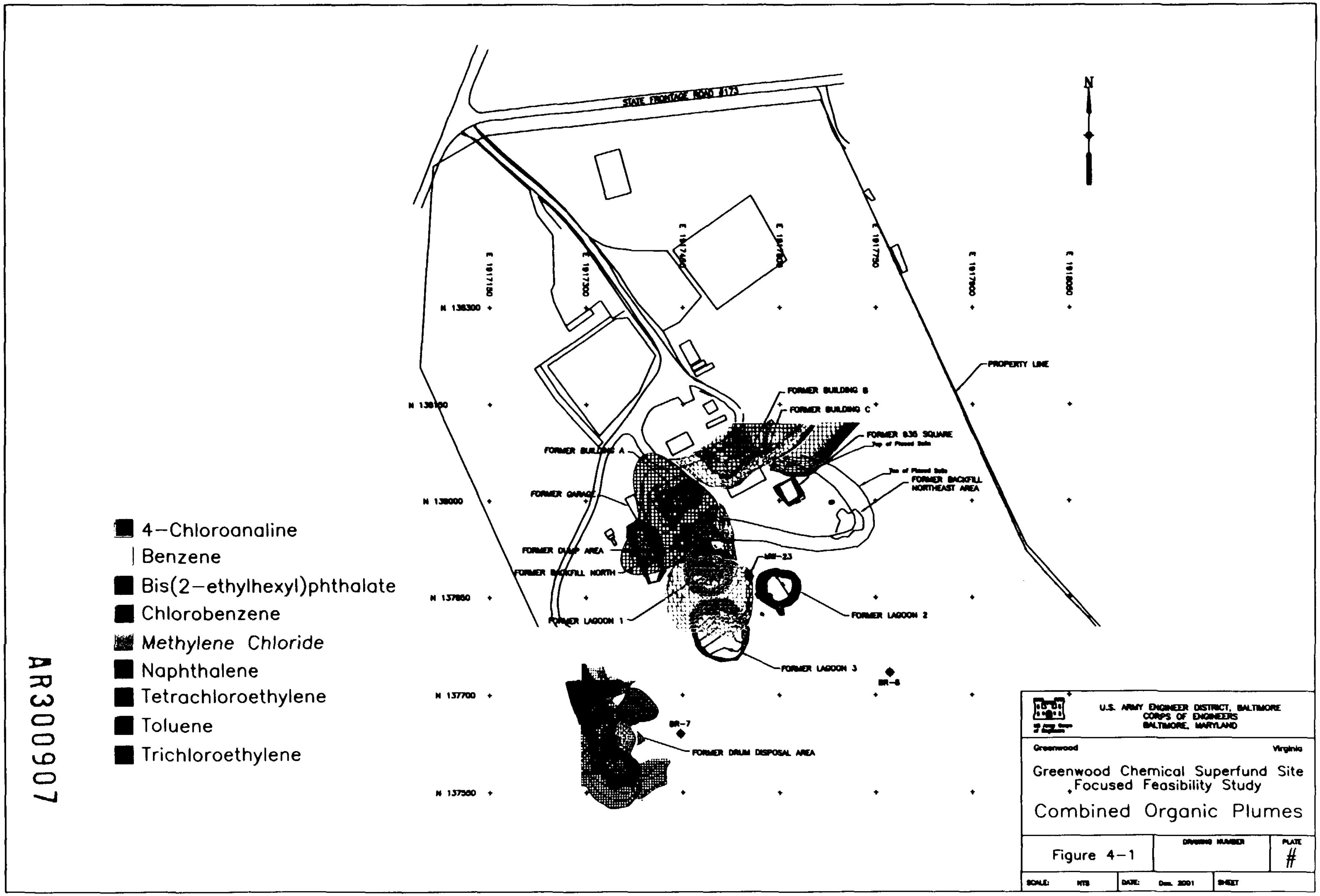
US Army Corps of Engineers

GREENWOOD VIRGINIA

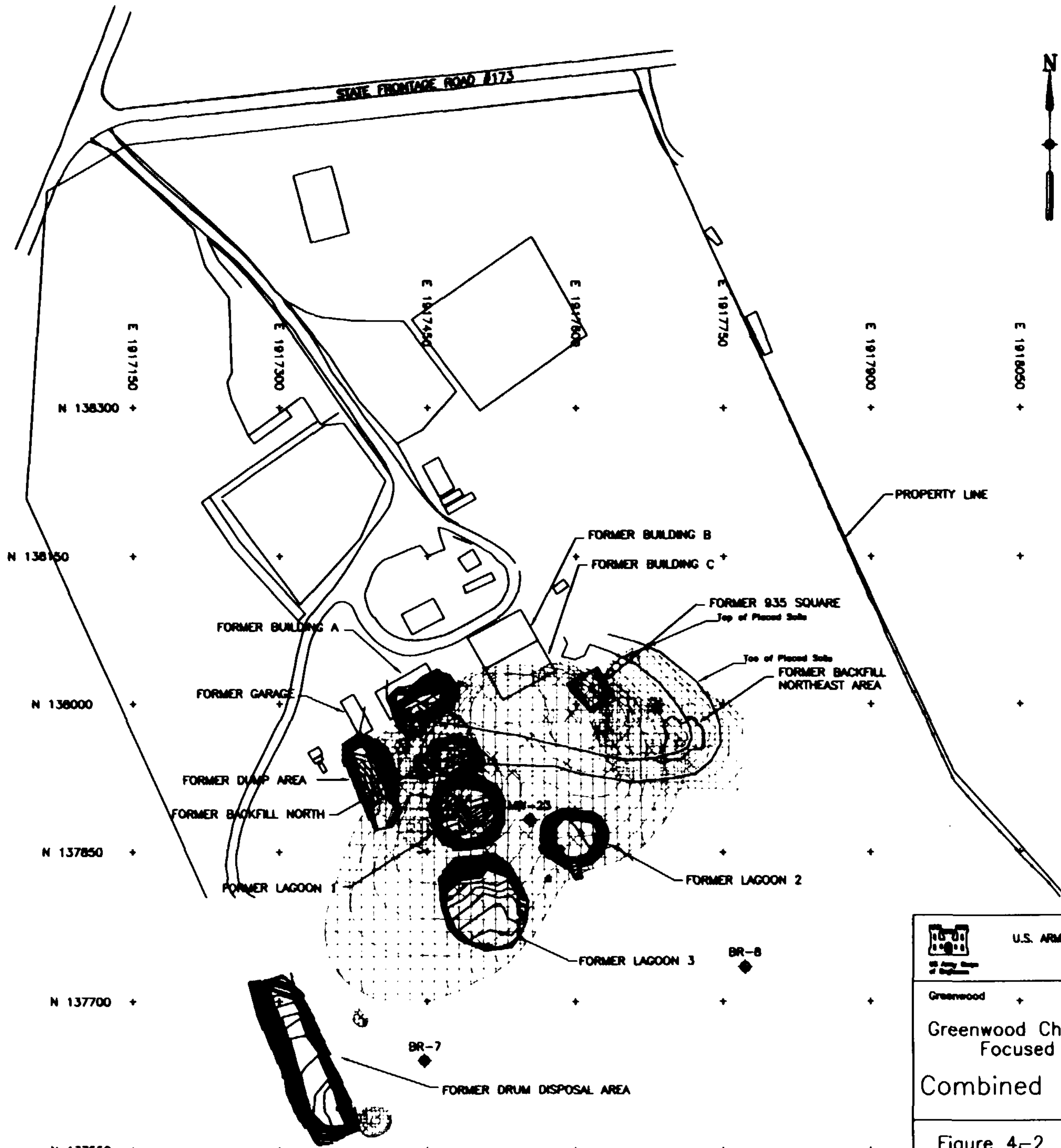
GREENWOOD CHEMICAL SUPERFUND SITE
FOCUSED FEASIBILITY STUDY

Cross–Sections 14+00 to 17+00

Figure 2-8	DRAWING NUMBER	PLATE #
SCALE: AS SHOWN	DATE: JAN 2002	SHEET



STATE FRONTAGE ROAD 873
N
PROPERTY LINE
FORMER BUILDING B
FORMER BUILDING C
FORMER BUILDING A
FORMER 836 SQUARE
FORMER BACKFILL NORTHEAST AREA
FORMER GARAGE
FORMER DUMP AREA
FORMER BACKFILL NORTH
MW-23
FORMER LAGOON 1
FORMER LAGOON 2
FORMER LAGOON 3
BR-6
BR-7
FORMER DRUM DISPOSAL AREA
N 138300
N 138150
N 138000
N 137850
N 137700
N 137550
E 1917150
E 1917300
E 1917750
E 1917900
E 1918050
4-Chloroanaline
Benzene
Bis(2-ethylhexyl)phthalate
Chlorobenzene
Methylene Chloride
Naphthalene
Tetrachloroethylene
Toluene
Trichloroethylene
U.S. ARMY ENGINEER DISTRICT, BALTIMORE
CORPS OF ENGINEERS
BALTIMORE, MARYLAND
Greenwood
Virginia
Greenwood Chemical Superfund Site
Focused Feasibility Study
Combined Organic Plumes
Figure 4-1
DRAWING NUMBER
PLATE
#
SCALE: NTS
DATE: Dec. 2001
SHEET



LEGEND

- Arsenic
- Cyanide

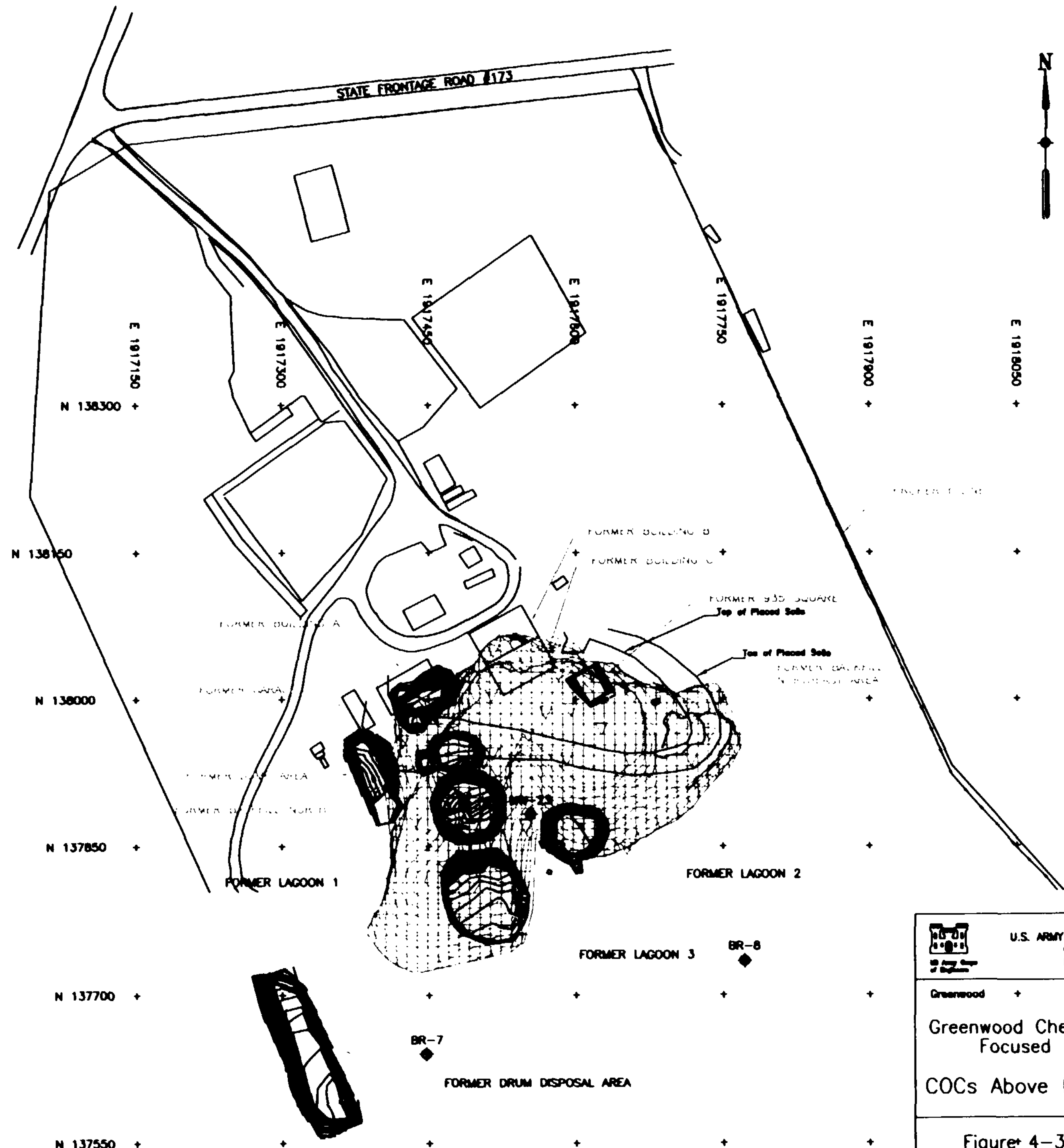
U.S. ARMY ENGINEER DISTRICT, BALTIMORE
CORPS OF ENGINEERS
BALTIMORE, MARYLAND

Greenwood | Virginia

Greenwood Chemical Superfund Site
Focused Feasibility Study

Combined Inorganic Plumes

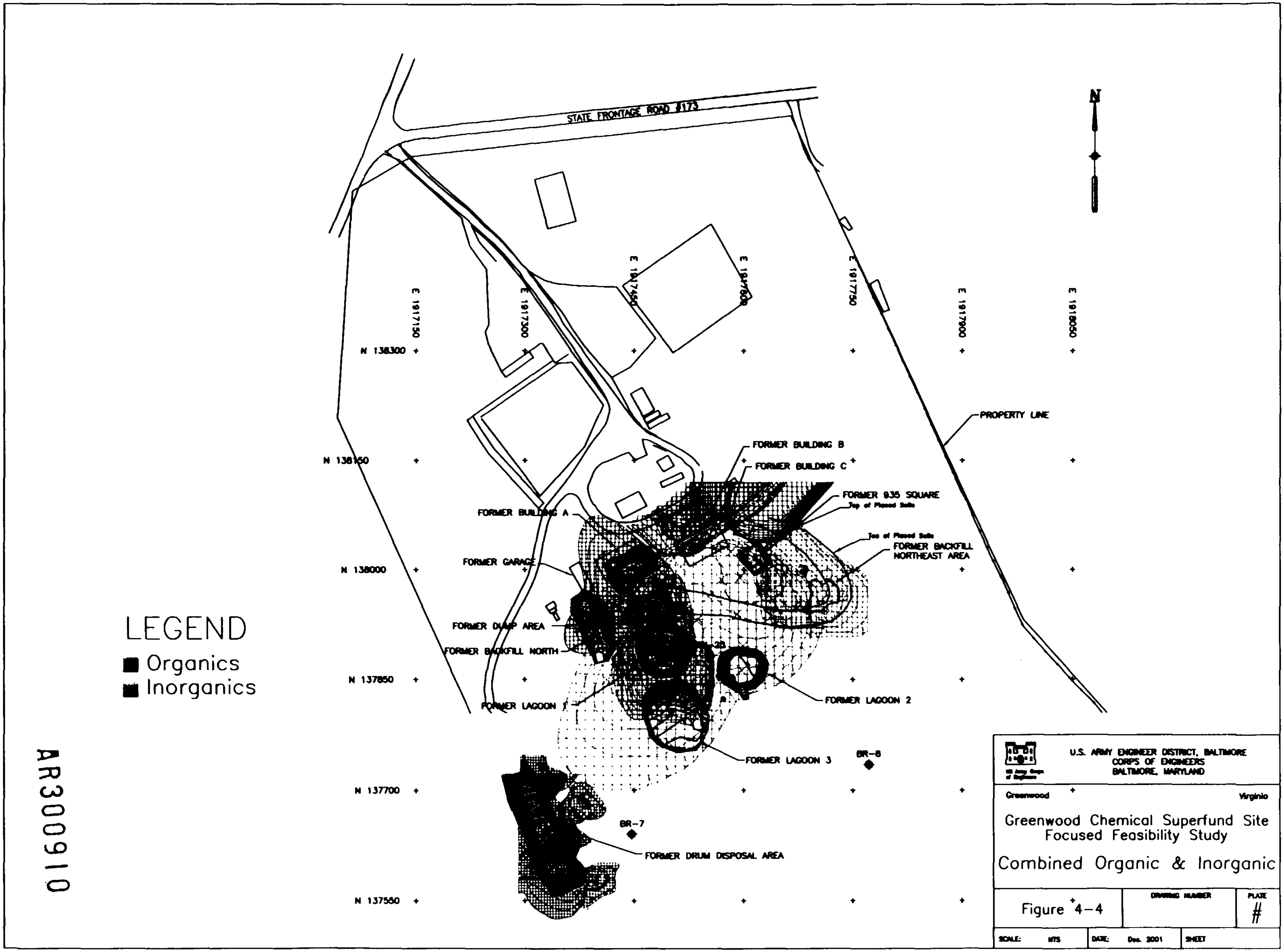
Figure 4-2	DRAWING NUMBER	PLATE #
SCALE: NTS	DATE: Dec 2001	SHEET



LEGEND

■ Arsenic

U.S. ARMY ENGINEER DISTRICT, BALTIMORE CORPS OF ENGINEERS BALTIMORE, MARYLAND	
Greenwood + Virginia	
Greenwood Chemical Superfund Site Focused Feasibility Study	
COCs Above Direct Contact PRG	
Figure 4-3	DRAWING NUMBER	PLATE #
SCALE: NTS	DATE: Dec 2001	SHEET



STATE FRONTAGE ROAD #173
N
E 1917150
E 1917300
E 1917450
E 1917600
E 1917750
E 1917900
E 1918050
N 138300
N 138150
N 138000
N 137850
N 137700
N 137550
PROPERTY LINE
FORMER BUILDING B
FORMER BUILDING C
FORMER 935 SQUARE
Top of Placed Soils
Toe of Placed Soils
FORMER BACKFILL NORTHEAST AREA
FORMER BUILDING A
FORMER GARAGE
FORMER DUMP AREA
FORMER BACKFILL NORTH
FORMER LAGOON 1
FORMER LAGOON 2
FORMER LAGOON 3
BR-8
BR-7
FORMER DRUM DISPOSAL AREA
LEGEND
Organics
Inorganics
AR300910
U.S. ARMY ENGINEER DISTRICT, BALTIMORE
CORPS OF ENGINEERS
BALTIMORE, MARYLAND
Greenwood
Virginia
Greenwood Chemical Superfund Site
Focused Feasibility Study
Combined Organic & Inorganic
Figure 4-4
DRAWING NUMBER
PLATE
#
SCALE: NTS
DATE: Dec. 2001
SHEET

TABLES

Table 3-1
Summary of Preliminary Remediation Goals
for the Protection of On-Site Groundwater

Compound	Modeled Groundwater Protection Goal (mg/kg)	Leachate-Derived Groundwater Protection Goal (mg/kg)
Acetone	1,462.1	600
Benzene[2]	0.0224/0.225	2.2
Chlorobenzene	7,708.7	16.6
Chloroform	0.219	60
1,2-dichloroethane	0.124	8
Methylene Chloride	10.83	0.16
Tetrachloroethene	0.2364	2.4
Tetrahydrofuran[1]	97,269	0.4
Toluene	101.4	600
Trichloroethene	0.0974	10
Naphthalene Acetic Acid[1]	158.6	1,360
Naphthalene	30	400
4-chloroanaline	565.7	2
Arsenic	136	400
Cyanide (total)[4]	340	14.6
Bis(2-ethylhexyl)phthalate (DEHP)	--	0.3
Dibutyl phthalate	--	3
2,4,6- trichlorophenol	--	NA[3]

Note 1 – Tetrahydrofuran was used as a surrogate compound for the volatile TICs in the RI. Naphthalene Acetic Acid was used as a surrogate compound for the semi-volatile TICs in the RI.
Note 2 - Level 0.0224 mg/kg applies to the Drum Disposal Area and level 0.225 mg/kg applies to the Manufacturing Area.
Note 3 - All SPLP results for 2,4,6- trichlorophenol were at the detection limit which is greater than the MCL; therefore groundwater protection the limit is unknown, but less than the detection limit in soil.
Note 4 - Free cyanide was measured as total cyanide

Table 3-2
Chemical-Specific Federal and State ARARs

Contaminant	Media	Citation	Requirement	Discussion
Multiple	Soil	None	None	There are no chemical-specific federal regulations or standards for the remediation of soil.
Multiple	Groundwater	None	None	Groundwater is not included as part of this OU; however, the protection of the groundwater at the MCL was considered.
Multiple	Air	None	None	See action-specific ARARs table for discussion of dust during remedial action.

Table 3-3
Location-Specific Federal and State ARARs

	Law/Regulation	Requirement Synopsis	Status	Discussion
State	General Provisions Relating to Marine Resources Commission, Va. Code Ann §§28.2-1300 to 1320	Sets forth the goals, needs and criteria for wetlands preservation and prevention of despoliation and destruction.	Not applicable	Not applicable – covered wetlands are not present within this operating unit.
State/Local	Chesapeake Bay Preservation Act, Va. Code Ann. §§10.1-2100 to 2116	Sets forth requirements to control non-point source water pollution.	Applicable	Applicable – Site is located in the primary drinking water supply watershed. Albemarle County requires protection of stream buffers.
State	Endangered Species, Va. Code Ann. §§29.1-563 to 570	Provisions prohibit the taking of endangered species.	Not applicable	Not Applicable – protected endangered species are not present within this operating unit.
State	Virginia Natural Preserves Act, Va. Code Ann. §§10.1-209 to 217	Provisions restrict certain uses of natural preserve area designated under this Act.	Not applicable	Not Applicable – designated preserves do not exist in the vicinity of Greenwood Chemical Site.
State	Endangered Plant and Insect Species Act, §§ 3.1-1020 to 1030	Provisions prohibit the taking of endangered plant and insect species.	Not applicable	Not Applicable – activity will not affect any state listed plant or insects.

Table 3-4
Action-Specific Federal and State ARARs and TBCs

	Law/Regulation/Policy	Requirement Synopsis	Status	Discussion
State	Virginia DEQ Policy for Handling of Investigation Derived Waste, 7/1996	Policy provides guidance for managing investigation derived wastes	TBC Item	Alternatives that result in generation of investigation derived wastes will need to follow the policy and the applicable Virginia State Regulations. Because this is not a promulgated regulation, it cannot be an ARAR.
State	State Water Control Law, Va. Code Ann. §§ 62.1-44.2 to 44.34:28	Virginia Pollution Discharge Elimination System Permit Regulations establishes permit, monitoring, and reporting requirements for the management and discharge of surface waters.	To be Determined	Alternatives that result in discharge of surface run-off and contaminated groundwater will need to comply with the substantive requirements of the law.
State	Virginia Waste Management Act, Va. Code Ann. §§ 10.1-1400 to 1457.	Regulations cover the generation, storage, transportation and disposal of solid and hazardous waste	To be Determined	Alternatives that result in management of covered waste will need to comply with the substantive requirements of the law.
State	Air Pollution Control Board, Va. Code Ann. §§10.1-1300 to 1326.	Sets forth standards for control of visible and fugitive dust emissions.	To be Determined	Alternatives that result in regulated air emissions will need to comply with the substantive requirement of the law.
State and Local	Stormwater Management Act, Va. Code Ann. §§ 10.1 – 603.1 to 603.15.	Sets forth requirements for non-point source pollution through erosion and sediment control related to land development and disturbance activities.	To be Determined	Alternatives that include excavation, grading or any land disturbance activity must comply with the substantive requirements of the law.

Table 3-5
Summary of Final Preliminary Remediation Goals

Contaminant of Concern	Surface Soil Risk-Based PRG (mg/kg)	Deep Soils On-Site Groundwater-Based PRG (mg/kg)	Deep Soils Off-Site Groundwater-Based PRG (mg/kg)
1,2-Dichloroethane (EDC)		0.400	8
2,4,6-Trichlorophenol		<.400*	0
4-Chloroanaline		0.100	2
Acetone		30	600
Arsenic (as carcinogen)	37	20	400
Benzene		0.110	2.2
Bis(2-ethylhexyl)phthalate (DEHP)		0.015	0.3
Chlorobenzene		0.830	16.6
Chloroform		3	60
Dibutyl phthalate		0.150	3
Free Cyanide[a]	136,875	0.730	14.6
Methylene Chloride		0.008	0.16
Naphthalene		20	400
Naphthalene Acetic Acid		68	1,360
Tetrachloroethylene (PCE)		0.120	2.4
Tetrahydrofuran		0.020	0.4
Toluene		30	600
Trichloroethylene (TCE)		0.500	10
Xylene (mixed)		58	1,160

* All SPLP results for 2,4,6- trichlorophenol were at the detection limit which is greater than the MCL; therefore, the groundwater protection limit is unknown, but less than the detection limit in soil.

[a] Free cyanide was measured as total cyanide

Table 4-1
Contaminants of Concern and Preliminary Remediation Goals (mg/kg)

Contaminant of Concern	Surface Soil Risk-Based PRG (mg/kg)	Deep Soils Off-Site Ground-water Based PRG (mg/kg)	Maximum Concentration Detected (mg/kg)	
			Drum Disposal Area	Manufacturing Area
1,2-Dichloroethane (EDC)	N/A	8	0.229	3.39
2,4,6-Trichlorophenol	N/A	Undetermined*	ND	ND
4-Chloroanaline	N/A	2	32	48
Acetone	N/A	600	70.3	201.3
Arsenic (as carcinogen)	37	400	1050	7120
Benzene	N/A	2.2	4.3	3.53
Bis(2-ethylhexyl)phthalate (DEHP)	N/A	0.3	0.9	0.91
Chlorobenzene	N/A	16.6	17	23
Chloroform	N/A	60	17	0.59
Dibutyl phthalate	N/A	3	0.14	0.063
Free Cyanide[a]	136,875	14.6	80.3	1000
Methylene Chloride	N/A	0.16	61	11
Naphthalene	N/A	400	1780	130
Naphthalene Acetic Acid	N/A	1,360	2.1	68
Tetrachloroethylene (PCE)	N/A	2.4	8.2	4.49
Tetrahydrofuran	N/A	0.4	ND	9000
Toluene	N/A	600	5900	620
Trichloroethylene (TCE)	N/A	10	0.011	50
Xylene (total)	N/A	1,160	ND	58

* All SPLP results for 2,4,6- Trichlorophenol were non-detect (ND), however, the detection limit violated the MCL so a PRG could not be determined.
[a] Free cyanide was measured as total cyanide
Shaded values exceed groundwater based PRG

Table 4-2
Volume Estimates for Combined COC Plumes Above Protection of Groundwater PRGs

Area	Area of Plume (ft^2)	Volume (ft^3)
Manufacturing Area	127,500	2,508,500
Drum Disposal Area	23,800	638,500

Table 4-3
Volume Estimate for Soils Above Direct Contact PRG

Contaminant of Concern	Drum Disposal Area		Manufacturing Area	
	Area (ft^2)	Volume (ft^3)	Area (ft^2)	Volume (ft^3)
Arsenic (as carcinogen)	22,000	44,000	80,000	160,000
Free Cyanide	22,000	44,000	0	0

Note 1: Volume estimates based on a removal depth of two feet.

Note 2: Volume for Drum Disposal Area assumes contamination exists on an 0.5 acre area located adjacent to t

Table 5-1
Technology Types and Process Options

Remedial Technology	Process Option	Description	Effectiveness	Implementability	Cost
No Action		No Action	Does not achieve remedial action objectives	May not be acceptable to state	None
Containment	Cap	RCRA Subtitle C (impermeable cap) or D (permeable cap) construction	Impermeable--does not remove or reduce COCs, but does reduce risk by decreasing mass transport to groundwater and eliminating direct contact. Permeable---reduces COCs by removing contaminated surface soil (0-2 feet), and eliminates risk associated with direct contact. Permeable cap slightly reduces risk associated with mass transport to groundwater via removing "hot spot" inorganic contamination.	Readily implemented	Low to moderate capital, low O&M costs
In Situ Biological Treatment	Enhanced Biodegradation	Metabolic breakdown of contaminants as a result of naturally occurring microbes	Effectiveness depends on delivery of nutrients, oxygen, other amendments	Injection of solutions may be difficult to accept	Moderate capital and O&M costs
	Bioventing	Forced air movements increases oxygen concentration in soil to facilitate biodegradation	Effectiveness depends on delivery of oxygen	Difficult to deliver oxygen due to high clay content found at the site	Moderate capital and O&M costs
	Natural Attenuation	Biological and chemical degradation and dispersion of contaminants in soil	*May achieve objectives in the long term*	*May favorable than no action*	Low capital and O&M costs
In Situ Physical/Chemical Treatment	Soil flushing	Water, or water containing an additive is applied to the soil or injected into the groundwater to raise the water table to the contaminated soil zone; contaminants leech into the groundwater which is then extracted and treated	May achieve objectives however, uncertainty exists over use of cosolvents	Injection of cosolvents complex, may be difficult to accept	Low capital, moderate to high O&M costs
	Soil Vapor Extraction	Gas phase volatiles are forced to diffuse through the soil through the application of a vacuum at extraction wells	Effectiveness depends on the ability to achieve air flow through soil	Difficult to achieve air flow due to high clay content found at the site	Moderate capital costs, moderate to high O&M costs depending on duration of operation
	Stabilization/ Solidification	Contaminated soil is mixed with amendments that fix COCs to restrict mobility via leaching	Can achieve objectives for inorganic COCs	Readily implemented	Low to moderate capital
In Situ Thermal Treatment	Thermally Enhanced SVE	The mobility of volatiles is enhanced via the application of various heating processes	May achieve objectives for most COCs, lower vapor pressure COCs are better treated w/ thermal enhancement	Development at pilot level only - no full scale implementation to date	Moderate capital costs, moderate to high O&M costs depending on duration of operation
	In Situ Vitrification	Electrodes are used to melt contaminated soils producing a glass and crystalline matrix with low leeching characteristics	Very effective in treating all COCs	Not suitable for larger scale application at greater depths	High capital and O&M costs
Ex Situ Biological Treatment	Composting	Bulking agents are added to soil to increase moisture and porosity, and provide a source of degradable carbon. Water, oxygen, and nutrients are added to facilitate bacterial growth			

Remedial Technology	Process Option	Description	Effectiveness	Implementability	Cost
	Controlled Solid Phase Biological Treatment	Excavated contaminated soil is spread in a thin layer on the ground surface; aerobic microbe activity is stimulated through aeration, and/or the addition of minerals, nutrients, and moisture			
	Landfarming	Contaminated surface soil is treated in place by tilling to achieve aeration; soil amendments are added to enhance biological activity.			
	Slurry Phase Biological Treatment	Soil-water slurry is continuously mixed with appropriate nutrients under controlled conditions; usually aerobic process			
Ex Situ Physical/Chemical Treatment	Chemical	Chemical reagents are added to soil for the purpose of contaminant destruction			
	Dehalogenation (BCD)	Contaminated soil is screened, processed and mixed with NaOH and catalysts; the mixture is heated to dehalogenated and partially volatilize the contaminants			
	Dehalogenation	Used for aromatic halogenated compounds; products are glycol-ether and/or hydroxylated compound and an alkali metal-salt-water by product			
	Soil Washing	Extraction process which uses a water based fluid as a solvent.			
	Soil Vapor Extraction	The mobility of volatiles is enhanced via the application of various heating processes			
	Solvent Extraction	Contaminants are dissolved or physically separated from soil using a solvent that is mixed with contaminated soil			
Ex Situ Thermal Treatment	High Temp. Thermal	Soils are heated to a temperature of 450 degrees C			
	Incineration	Heating soil in the presence of oxygen to burn or oxidize organic materials; does not remove metals			
	Low Temp. Thermal	Soils are heated to a maximum temperature of 290 degrees C			
	Pyrolysis	Solids are heated in the absence of oxygen			
	Vitrification	Electrodes are used to melt contaminated soils producing a glass and crystalline matrix with low leeching characteristics			
Excavation	Excavation and Off-Site Disposal	Contaminated soil is removed and treated at an off-site facility.	Reduces risk and eliminates source of COC mass available to impact the groundwater.	Land Disposal Restrictions may apply. Excavation was implemented during OU-1 remedial actions in fall of 1996.	Inorganic contaminated soil near surface - low cost, no O&M. Organic contaminated soil - high cost, no O&M

Note - Gray-shaded remedial technologies were screened out.

Table 6-1
Detailed Analysis - Institutional Controls & No Remedial Action
Drum Disposal & Manufacturing Area

Remedial Technology – Institutional Controls & No Remedial Action - Alternative 1		
Process Option - NA		
Evaluation Criteria - Overall Protection of Human Health and the Environment (-)		
Analysis Factor	Analysis Factor Rating	Remarks
How alternative provides human health and environmental protection	-	No reduction in risk associated with exposure to arsenic or cyanide contaminated surface soils nor reduction in impact to groundwater from organic COCs in soils.
Evaluation Criteria - Compliance with ARARs (-)		
Analysis Factor	Analysis Factor Rating	Remarks
Compliance with chemical-specific ARARs	NA	
Compliance with Action-specific ARARs	NA	
Compliance with Location-specific ARARs	-	This site is located in a primary drinking water supply watershed. The NO REMEDIAL ACTION alternative would allow COCs to continue leaching into the groundwater.
Compliance with other criteria, advisories, and guidances	NA	

Table 6-1
Detailed Analysis - Institutional Controls & No Remedial Action
Drum Disposal & Manufacturing Area

Remedial Technology – Institutional Controls & No Remedial Action - Alternative 1		
Process Option		
Evaluation Criteria - Long-term Effectiveness and Permanence (-)		
Analysis Factor	Analysis Factor Rating	Remarks
Magnitude of residual risk	-	The NO REMEDIAL ACTION alternative does nothing to reduce the magnitude of the risk associated with the presence of COCs in the soils. The current sources of risk will remain unchanged except for reductions resulting from natural attenuation that would not be monitored.
Adequacy and reliability of controls	NA	No controls would be employed for the NO REMEDIAL ACTION alternative.

AR300922

Table 6-1
Detailed Analysis - Institutional Controls & No Remedial Action
Drum Disposal & Manufacturing Area

Remedial Technology – Institutional Controls & No Remedial Action - Alternative 1		
Process Option		
Evaluation Criteria - Reduction of Toxicity, Mobility, and Volume through Treatment (-)		
Analysis Factor	Analysis Factor Rating	Remarks
Treatment process and remedy	-	No treatment process would be employed for the NO REMEDIAL ACTION alternative.
Amount of hazardous material destroyed or treated	-	No hazardous material would be destroyed or treated for the NO REMEDIAL ACTION alternative.
Reduction in toxicity, mobility, or volume	-	There is no reduction, other than by natural attenuation, in the toxicity, mobility, or volume for the NO REMEDIAL ACTION alternative.
Irreversibility of the treatment	NA	NA
Type and quantity of treatment residual	NA	NA
Statutory preference for treatment as a principal element	-	The NO REMEDIAL ACTION alternative does satisfy the statutory preference for treatment of COCs.

AR300923

Table 6-1
Detailed Analysis - Institutional Controls & No Remedial Action
Drum Disposal & Manufacturing Area

Remedial Technology – Institutional Controls & No Remedial Action - Alternative 1		
Process Option		
Evaluation Criteria - Short-term Effectiveness (+)		
Analysis Factor	Analysis Factor Rating	Remarks
Protection of the community during remedial actions	+	The NO REMEDIAL ACTION alternative would pose no short-term risks arising from the implementation of a remedial action.
Protection of workers during remedial actions	+	The NO REMEDIAL ACTION alternative would pose no threats to workers implementing a remedial action.
Environmental impacts	+	The NO REMEDIAL ACTION alternative would pose no adverse environmental impacts resulting from construction activities.
Time until remedial response objectives are achieved	-	The NO REMEDIAL ACTION alternative would not meet the remedial response objectives.

AR300924

Table 6-1
Detailed Analysis - Institutional Controls & No Remedial Action
Drum Disposal & Manufacturing Area

Remedial Technology – Institutional Controls & No Remedial Action – Alternative 1		
Process Option		
Evaluation Criteria - Implementability (NA)		
Analysis Factor	Analysis Factor Rating	Remarks
Technical Feasibility		
Ability to construct and operate technology	NA	
Reliability of Technology	+	Institutional Controls such as deed restrictions, signs, and fencing would restrict use of property.
Ease of undertaking additional remedial action, if necessary	+	Future remedial action will not be hampered n NO REMEDIAL ACTION alternative.
Monitoring considerations	NA	
Administrative Feasibility		
Coordination with Other Agencies	NA	
Availability of services and materials		
Availability of treatment, storage capacity, and disposal services	NA	
Availability of necessary equipment and specialists	NA	
Availability of prospective technologies	NA	

Table 6-1
Detailed Analysis - Institutional Controls & No Remedial Action
Drum Disposal & Manufacturing Area

Remedial Technology – Institutional Controls & No Remedial Action – Alternative 1		
Process Option		
Evaluation Criteria - Cost (+)		
Analysis Factor	Analysis Factor Rating	Remarks
Capital Costs	+	$0.11 MILLION
Operating and maintenance costs	+	$0

Note: A positive (+) rating factor indicates that the analysis factor has been met. A negative (-) rating factor indicates that the analysis factor was not met.

Table 6-2
Detailed Analysis – Institutional Controls & Impermeable Capping
Manufacturing Area & Drum Disposal Area

Remedial Technology – Institutional Controls & Impermeable Cap - Alternative 2		
Process Option		
Evaluation Criteria - Overall Protection of Human Health and the Environment (0)		
Analysis Factor	Analysis Factor Rating	Remarks
How alternative provides human health and environmental protection	+	Controls exposure pathway by restricting contact with arsenic and cyanide contaminated soils and reducing infiltration and leaching of COC mass to groundwater.
Evaluation Criteria - Compliance with ARARs (+)		
Analysis Factor	Analysis Factor Rating	Remarks
Compliance with chemical-specific ARARs	NA	
Compliance with Action-specific ARARs	+	Land disturbance activities common to cap construction, such as grading and excavation, may generate fugitive dust emissions and promote erosion. These dust emission are easily controlled and minor due to the minimal amount of potentially contaminated soil disturbed during construction of the cap. During cap construction, erosion and sediment controls will be implemented.
Compliance with Location-specific ARARs	+	The site is located in the primary drinking water supply watershed. The IMPERMEABLE CAPPING alternative would restrict COCs from leaching into the groundwater.
Compliance with other criteria, advisories, and guidances	+	The IMPERMEABLE CAPPING alternative would be designed to meet EPA's recommended design criteria for Subtitle C facilities. It is important to note that this site is NOT a landfill. Design criteria for Subtitle C facilities were selected for this alternative strictly because Subtitle C facilities employ impermeable caps.

Table 6-2
Detailed Analysis – Institutional Controls & Impermeable Capping
Manufacturing Area & Drum Disposal Area

Remedial Technology – Institutional Controls & Impermeable Cap - Alternative 2		
Process Option		
Evaluation Criteria - Long-term Effectiveness and Permanence (+)		
Analysis Factor	Analysis Factor Rating	Remarks
Magnitude of residual risk	+	The IMPERMEABLE CAPPING alternative could reduce the magnitude of the residual risk by interrupting the physical mechanism that transports contaminant mass from the soil to the groundwater and reducing the risk associated with exposure to inorganics.
Adequacy and reliability of controls	+	The IMPERMEABLE CAPPING alternative would provide adequate and reliable control of the infiltration and exposure to inorganics in the shallow soil. The cap would require long-term maintenance; however, the maintenance is relatively simple (e.g. erosion prevention and control). Other than routine maintenance, there should be no need to replace technical components. Should the remedial action require replacement at some future time, the magnitude of the threats/risks would be the same as those faced today. There is a high degree of confidence that the controls can adequately handle potential problems. Since no wastes are excavated, Land Disposal Restrictions would not impact this alternative.

AR300928

Table 6-2
Detailed Analysis – Institutional Controls & Impermeable Capping
Manufacturing Area & Drum Disposal Area

Remedial Technology – Institutional Controls & Impermeable Cap - Alternative 2		
Process Option		
Evaluation Criteria - Reduction of Toxicity, Mobility, and Volume through Treatment (-)		
Analysis Factor	Analysis Factor Rating	Remarks
Treatment process and remedy	NA	
Amount of hazardous material destroyed or treated	-	The IMPERMEABLE CAPPING alternative does not destroy or treat any of the COCs.
Reduction in toxicity, mobility, or volume	-	The IMPERMEABLE CAPPING alternative does not reduce the toxicity, mobility, or volume of the COCs.
Irreversibility of the treatment	NA	
Type and quantity of treatment residual	NA	
Statutory preference for treatment as a principal element	-	The IMPERMEABLE CAPPING alternative does not satisfy the statutory preference for treatment of the COCs.

AR300929

Table 6-2
Detailed Analysis – Institutional Controls & Impermeable Capping
Manufacturing Area & Drum Disposal Area

Remedial Technology – Institutional Controls & Impermeable Cap - Alternative 2		
Process Option		
Evaluation Criteria - Short-term Effectiveness (+)		
Analysis Factor	Analysis Factor Rating	Remarks
Protection of the community during remedial actions	+	The IMPERMEABLE CAPPING alternative may pose some additional risk to the community resulting from dust generated during construction. These risks are easily controlled and minor due to the minimal amount of potentially contaminated soil disturbed during construction.
Protection of workers during remedial actions	+	The IMPERMEABLE CAPPING alternative may pose some additional risk to workers resulting from dust generated during construction. These risks are easily controlled and minor due to the minimal amount of potentially contaminated soil disturbed during construction.
Environmental impacts	+	The IMPERMEABLE CAPPING alternative may pose some additional risk to the environment resulting from storm water run-off generated during construction. These risks are easily controlled and minor due to the minimal amount of potentially contaminated soil disturbed during construction.
Time until remedial response objectives are achieved	+	The IMPERMEABLE CAPPING alternative can be in place and operational within a relatively short time frame.

Table 6-2
Detailed Analysis – Institutional Controls & Impermeable Capping
Manufacturing Area & Drum Disposal Area

Remedial Technology – Institutional Controls & Impermeable Cap - Alternative 2		
Process Option		
Evaluation Criteria - Implementability (+)		
Analysis Factor	Analysis Factor Rating	Remarks
Technical Feasibility		
Ability to construct and operate technology	+	The IMPERMEABLE CAPPING alternative is a known method and is relatively easy to construct and operate.
Reliability of technology	+	The IMPERMEABLE CAPPING alternative is reliable if properly maintained and will not lead to schedule delays.
Ease of undertaking additional remedial action, if necessary	-	The IMPERMEABLE CAPPING alternative may impact the operation of the groundwater pump and treat system by reducing the infiltration rate. This may be an advantage that reduces the operation of the pump and treat system. However, without modeling the impacts are uncertain. Once constructed, the IMPERMEABLE CAPPING alternative may limit any future actions for the soils that would require any intrusive work.
Monitoring considerations	+	The effectiveness of the IMPERMEABLE CAPPING alternative could be readily monitored. During implementation of the IMPERMEABLE CAPPING alternative, the exposure pathways through which contaminants may leave the site can be monitored. If the monitoring failed, the additional risk is small due to the minimal exposure of COC impacted soil during construction.
Administrative feasibility		
Coordination with other agencies	+	The IMPERMEABLE CAPPING alternative would be relatively easy to coordinate with other regulatory agencies.
Availability of services and materials		
Availability of treatment, storage capacity, and disposal	NA	

Table 6-2
Detailed Analysis – Institutional Controls & Impermeable Capping
Manufacturing Area & Drum Disposal Area

Remedial Technology – Institutional Controls & Impermeable Cap - Alternative 2		
Process Option		
Evaluation Criteria - Implementability (+)		
Analysis Factor	Analysis Factor Rating	Remarks
services		
Availability of necessary equipment and specialists	+	The equipment and specialists needed to implement the IMPERMEABLE CAPPING alternative are readily available.
Availability of prospective technologies	+	The technologies needed to implement the IMPERMEABLE CAPPING alternative are readily available.

Table 6-2
Detailed Analysis – Institutional Controls & Impermeable Capping
Manufacturing Area & Drum Disposal Area

Remedial Technology – Institutional Controls & Impermeable Cap - Alternative 3		
Process Option		
Evaluation Criteria - Cost (+)		
Analysis Factor	Analysis Factor Rating	Remarks
Capital Costs	+	$3.93 MILLION
Operating and maintenance costs	+	$1.42 MILLION

Note: A positive (+) rating factor indicates that the analysis factor has been met. A negative (-) rating factor indicates that the analysis factor was not met.

AR300933

Table 6-3
Detailed Analysis – Institutional Controls & Excavation
Manufacturing Area

Remedial Technology – Institutional Controls & Excavation - Alternative 1		
Process Option		
Evaluation Criteria - Overall Protection of Human Health and the Environment (+)		
Analysis Factor	Analysis Factor Rating	Remarks
How alternative provides human health and environmental protection	+	The EXCAVATION alternative reduces the risk on the site associated with all impacted soils.
Evaluation Criteria - Compliance with ARARs (+)		
Analysis Factor	Analysis Factor Rating	Remarks
Compliance with chemical-specific ARARs	NA	
Compliance with Action-specific ARARs	+	Land disturbance activities, such as grading and excavation, may generate fugitive dust emissions and promote erosion. Maintaining acceptable moisture content during excavation easily controls these dust emission. Storm water management and sediment controls will be implemented during excavation activities to prevent erosion. The Land Disposal Restrictions would most likely impact this option by requiring treatment of the soils prior to disposal.
Compliance with Location-specific ARARs	+	The site is located in the primary drinking water supply watershed. The soils above preliminary remediation goals would be excavated and disposed off-site, thereby protecting the off-site groundwater.
Compliance with other criteria, advisories, and guidances	NA	

Table 6-3
Detailed Analysis – Institutional Controls & Excavation
Manufacturing Area

Remedial Technology – Institutional Controls & Excavation - Alternative 1		
Process Option		
Evaluation Criteria - Long-term Effectiveness and Permanence (+)		
Analysis Factor	Analysis Factor Rating	Remarks
Magnitude of residual risk	+	The EXCAVATION alternative allows reduces the residual risk to acceptable levels.
Adequacy and reliability of controls	+	The EXCAVATION alternative addresses this analysis factor as follows • The technology will most likely meet the performance specification. • No long-term management or monitoring is required for the deep soils. • No operation and maintenance functions must be performed once the remedy is completed. • There are no uncertainties associated with the long-term operation and maintenance. • There is no need for the replacement of system components. • There are no threats or risks associated with the replacement of the remedial action. • The Land Disposal Restrictions would most likely impact this option by requiring treatment of the soils prior to disposal.

Table 6-3
Detailed Analysis – Institutional Controls & Excavation
Manufacturing Area

Remedial Technology – Institutional Controls & Excavation - Alternative 1		
Process Option		
Evaluation Criteria - Reduction of Toxicity, Mobility, and Volume through Treatment (+)		
Analysis Factor	Analysis Factor Rating	Remarks
Treatment process and remedy	+	The specific treatment is unknown at this time, however presumed to be required at the TSDF by Land Disposal Restrictions. The treatment at the TSDF would address the principal threat posed by the COCs.
Amount of hazardous material destroyed or treated	+	All COC impacted material that exceeds the clean-up goals would be excavated and transported to the TSDF. All material received by the TSDF would most likely be treated prior to disposal.
Reduction in toxicity, mobility, or volume	+	Relative to the site, the toxicity, mobility, and volume are all reduced. From a bigger perspective, the toxicity, mobility, and volume would be addressed at the TSDF.
Irreversibility of the treatment	+	Treatment employed by TSDF presumed to be irreversible.
Type and quantity of treatment residual	+	The treatment residuals would most likely remain at the TSDF; however, the exact quantity and composition are unknown at this time. These residuals would be disposed at the TSDF and meet the requirements of the selected facility.
Statutory preference for treatment as a principal element	+	The EXCAVATION alternative would meet statutory preference for treatment by treating soils prior to disposal.

Table 6-3
Detailed Analysis – Institutional Controls & Excavation
Manufacturing Area

Remedial Technology – Institutional Controls & Excavation - *Alternative 1*		
Process Option		
Evaluation Criteria - Short-term Effectiveness (0)		
Analysis Factor	Analysis Factor Rating	Remarks
Protection of the community during remedial actions	+	The EXCAVATION alternative would require controls in order to minimize potential risks to the community posed by airborne dust during excavation. These risks can be readily controlled using common methods.
Protection of workers during remedial actions	+	The EXCAVATION alternative would require controls in order to minimize risks to site workers posed by dust, exposures to contaminated soils, and vaporization of COCs. These risks can be readily controlled.
Environmental impacts	+	The EXCAVATION alternative would require controls in order to minimize impacts to the environment due to storm water run-off during excavation. These impacts can be readily controlled.
Time until remedial response objectives are achieved	+	The EXCAVATION alternative can relatively quickly addresses the threats and achieves remedial response objectives in a relatively short time period.

AR300937

Table 6-3
Detailed Analysis – Institutional Controls & Excavation
Manufacturing Area

Remedial Technology – Institutional Controls & Excavation - Alternative 1		
Process Option		
Evaluation Criteria - Implementability (+)		
Analysis Factor	Analysis Factor Rating	Remarks
Technical Feasibility		
Ability to construct and operate technology	+	The EXCAVATION alternative is relatively easy to construct using standard practices and methods. However, there is considerable uncertainty as to the extent of contamination in the subsurface for purposes of estimating volumes.
Reliability of Technology	+	Due to its simplicity, the EXCAVATION alternative is very reliable and would not lead to schedule delays.
Ease of undertaking additional remedial action, if necessary	+	The EXCAVATION alternative would not adversely impact the implementation of remedial actions at other OUs and would be a final remedy for OU4.
Monitoring considerations	+	Exposure pathways during implementation can be monitored. In the event of a monitoring failure, there could be a minimal increase in risk to workers or the surrounding community. However, the potential increase is relatively small due to the low population density in the vicinity of the site.
Administrative Feasibility		
Coordination with other Agencies	+	The EXCAVATION alternative would require coordination with other agencies in order to transport contaminated material for off-site disposal. The EXCAVATION alternative was previously accomplished for the removal of contaminated soils and sludges.
Availability of services and materials		
Availability of treatment, storage capacity, and disposal services	+	Adequate treatment storage, capacity, and disposal services are available.
Availability of necessary equipment and specialists	+	Equipment and specialists are readily available to implement this alternative.

Table 6-3
Detailed Analysis – Institutional Controls & Excavation
Manufacturing Area

Remedial Technology – Institutional Controls & Excavation - Alternative 1		
Process Option		
Evaluation Criteria - Implementability (+)		
Analysis Factor	Analysis Factor Rating	Remarks
Availability of prospective technologies	+	The EXCAVATION alternative employs methods, equipment and specialists that are readily available from more than one vendor and are sufficiently demonstrated. It is likely that competitive bids would be possible.

Table 6-3
Detailed Analysis – Institutional Controls & Excavation
Manufacturing Area

Remedial Technology – Institutional Controls & Excavation - Alternative 1		
Process Option		
Evaluation Criteria - Cost (-)		
Analysis Factor	Analysis Factor Rating	Remarks
Capital Costs	-	$78.30 MILLION
Operating and maintenance costs	+	$0

Note: A positive (+) rating factor indicates that the analysis factor has been met. A negative (-) rating factor indicates that the analysis factor was not met.

AR300940

Table 6-4
Detailed Analysis – Institutional Controls & Permeable Cap
Manufacturing Area

Remedial Technology – Institutional Controls & Permeable Cap - Alternative 2		
Process Option		
Evaluation Criteria - Overall Protection of Human Health and the Environment (+)		
Analysis Factor	Analysis Factor Rating	Remarks
How alternative provides human health and environmental protection	+	The PERMEABLE CAPPING alternative reduces the risk on the site associated with all impacted soils.
Evaluation Criteria - Compliance with ARARs (+)		
Analysis Factor	Analysis Factor Rating	Remarks
Compliance with chemical-specific ARARs	NA	
Compliance with Action-specific ARARs	+	Land disturbance activities, such as grading and excavation, may generate fugitive dust emissions and promote erosion. These dust emission are easily controlled by maintaining acceptable moisture content during excavation of the top 0-2 feet of exposed contamination. Storm water management and sediment controls will be implemented during excavation activities to prevent erosion. The Land Disposal Restrictions may impact this option by requiring treatment of the soils prior to disposal.
Compliance with Location-specific ARARs	-	The site is located in the primary drinking water supply water shed. The PERMEABLE CAPPING alternative would NOT restrict COCs from leaching into the groundwater.
Compliance with other criteria, advisories, and guidances	+	The PERMEABLE CAPPING alternative would be designed to meet EPA's recommended design criteria for Subtitle D facilities. Subtitle D facilities are typically for non-hazardous landfills. However, because this site is NOT a landfill and the in-place groundwater treatment facility will address groundwater

Table 6-4

Detailed Analysis – Institutional Controls & Permeable Cap

Manufacturing Area

		contamination, Subtitle D cap design requirements are appropriate for the PERMEABLE CAPPING alternative. Direct contact will be eliminated once the soil cap is constructed.

Table 6-4
Detailed Analysis – Institutional Controls & Permeable Cap
Manufacturing Area

Remedial Technology – Institutional Controls & Permeable Cap - Alternative 2		
Process Option		
Evaluation Criteria - Long-term Effectiveness and Permanence (+)		
Analysis Factor	Analysis Factor Rating	Remarks
Magnitude of residual risk	+	The PERMEABLE CAPPING alternative allows reduces the residual risk to acceptable levels.
Adequacy and reliability of controls	+	The PERMEABLE CAPPING alternative addresses this analysis factor as follows • The technology will most likely meet the performance specification. • No long-term management or monitoring is required for the deep soils. • No operation and maintenance functions must be performed once the remedy is completed. • There are no uncertainties associated with the long-term operation and maintenance. • There is no need for the replacement of system components. • There are no threats or risks associated with the replacement of the remedial action. • The Land Disposal Restrictions would most likely impact this option by requiring treatment of the soils prior to disposal.

Table 6-4
Detailed Analysis – Institutional Controls & Permeable Cap
Manufacturing Area

Remedial Technology – Institutional Controls & Permeable Cap - Alternative 2		
Process Option		
Evaluation Criteria - Reduction of Toxicity, Mobility, and Volume through Treatment (+)		
Analysis Factor	Analysis Factor Rating	Remarks
Treatment process and remedy	+	The specific treatment is unknown at this time; however presumed to be required at the TSDF by Land Disposal Restrictions. The treatment at the TSDF would address the principal threat posed by the COCs.
Amount of hazardous material destroyed or treated	+	All COC impacted material that exceeds the clean-up goals would be excavated and transported to the TSDF. All material received by the TSDF would most likely be treated prior to disposal.
Reduction in toxicity, mobility, or volume	+	Relative to the site, the toxicity, mobility, and volume are all reduced. From a bigger perspective, the toxicity, mobility, and volume would be addressed at the TSDF.
Irreversibility of the treatment	+	Treatment employed by TSDF presumed to be irreversible.
Type and quantity of treatment residual	+	The treatment residuals would most likely remain at the TSDF; however, the exact quantity and composition are unknown at this time. These residuals would be disposed at the TSDF and meet the requirements of the selected facility.
Statutory preference for treatment as a principal element	+	The PERMEABLE CAPPING alternative would meet statutory preference for treatment by treating soils prior to disposal.

AR300944

Table 6-4
Detailed Analysis – Institutional Controls & Permeable Cap
Manufacturing Area

Remedial Technology – Institutional Controls & Permeable Cap - Alternative 2		
Process Option		
Evaluation Criteria – Short-term Effectiveness (+)		
Analysis Factor	Analysis Factor Rating	Remarks
Protection of the community during remedial actions	+	The PERMEABLE CAPPING alternative would require controls in order to minimize potential risks to the community posed by airborne dust during PERMEABLE CAPPING. These risks can be readily controlled using common methods.
Protection of workers during remedial actions	+	The PERMEABLE CAPPING alternative would require controls in order to minimize risks to site workers posed by dust, exposures to contaminated soils, and vaporization of COCs. These risks can be readily controlled.
Environmental impacts	+	The PERMEABLE CAPPING alternative would require controls in order to minimize impacts to the environment due to storm water run-off during PERMEABLE CAPPING. These impacts can be readily controlled.
Time until remedial response objectives are achieved	+	The PERMEABLE CAPPING alternative can relatively quickly addresses the threats and achieves remedial response objectives in a relatively short time period.

AR300945

Table 6-4
Detailed Analysis – Institutional Controls & Permeable Cap
Manufacturing Area

Remedial Technology – Institutional Controls & Permeable Cap - Alternative 2		
Process Option		
Evaluation Criteria – Implementability (+)		
Analysis Factor	Analysis Factor Rating	Remarks
		Technical Feasibility
Ability to construct and operate technology	+	The PERMEABLE CAPPING alternative is relatively easy to construct using standard practices and methods. However, there is considerable uncertainty as to the extent of contamination in the subsurface for purposes of estimating volumes.
Reliability of Technology	+	Due to its simplicity, the PERMEABLE CAPPING alternative is very reliable and would not lead to schedule delays.
Ease of undertaking additional remedial action, if necessary	+	The PERMEABLE CAPPING alternative would not adversely impact the implementation of remedial actions at other OUs and would be a final remedy for OU 4.
Monitoring considerations	+	Exposure pathways during implementation can be monitored. In the event of a monitoring failure, there could be a minimal increase in risk to workers or the surrounding community. However, the potential increase is relatively small due to the low population density in the vicinity of the site.
		Administrative Feasibility
Coordination with other Agencies	+	The PERMEABLE CAPPING alternative would require coordination with other agencies in order to transport contaminated material for off-site disposal. Excavation was previously accomplished for the removal of contaminated soils and sludges.
		Availability of services and materials
Availability of treatment, storage capacity, and disposal services	+	Adequate treatment storage, capacity, and disposal services are available.
Availability of necessary equipment and specialists	+	Equipment and specialists are readily available to implement this alternative.

AR300946

Table 6-4
Detailed Analysis – Institutional Controls & Permeable Cap
Manufacturing Area

Remedial Technology – Institutional Controls & Permeable Cap - Alternative 2		
Process Option		
Evaluation Criteria – Implementability (+)		
Analysis Factor	Analysis Factor Rating	Remarks
Availability of prospective technologies	+	The PERMEABLE CAPPING alternative employs methods, equipment and specialists that are readily available from more than one vendor and are sufficiently demonstrated. It is likely that competitive bids would be possible.

Table 6-4
Detailed Analysis – Institutional Controls & Permeable Cap
Manufacturing Area

Remedial Technology – Institutional Controls & Permeable Cap - Alternative 2		
Process Option		
Evaluation Criteria - Cost (+)		
Analysis Factor	Analysis Factor Rating	Remarks
Capital Costs	+	$5.91 MILLION
Operating and maintenance costs	+	$0

Note: A positive (+) rating factor indicates that the analysis factor has been met. A negative (-) rating factor indicates that the analysis factor was not met.

Table 6-5
Detailed Analysis – Institutional Controls & Impermeable Capping
Manufacturing Area

Remedial Technology – Institutional Controls & Impermeable Cap - Alternative 3		
Process Option		
Evaluation Criteria - Overall Protection of Human Health and the Environment (0)		
Analysis Factor	Analysis Factor Rating	Remarks
How alternative provides human health and environmental protection	+	Controls exposure pathway by restricting contact with arsenic and cyanide contaminated soils and reducing infiltration and leaching of COC mass to groundwater.
Evaluation Criteria - Compliance with ARARs (+)		
Analysis Factor	Analysis Factor Rating	Remarks
Compliance with chemical-specific ARARs	NA	
Compliance with Action-specific ARARs	+	Land disturbance activities common to cap construction, such as grading and excavation, may generate fugitive dust emissions and promote erosion. These dust emission are easily controlled and minor due to the minimal amount of potentially contaminated soil disturbed during construction of the cap. During cap construction, erosion and sediment controls will be implemented.
Compliance with Location-specific ARARs	+	The site is located in the primary drinking water supply watershed. The IMPERMEABLE CAPPING alternative would restrict COCs from leaching into the groundwater.
Compliance with other criteria, advisories, and guidances	+	The IMPERMEABLE CAPPING alternative would be designed to meet EPA's recommended design criteria for Subtitle C facilities. It is important to note that this site is NOT a landfill. Design criteria for Subtitle C facilities were selected for this alternative strictly because Subtitle C facilities employ impermeable caps.

Table 6-5
Detailed Analysis – Institutional Controls & Impermeable Capping
Manufacturing Area

Remedial Technology – Institutional Controls & Impermeable Cap - Alternative 3		
Process Option		
Evaluation Criteria - Long-term Effectiveness and Permanence (+)		
Analysis Factor	Analysis Factor Rating	Remarks
Magnitude of residual risk	+	The IMPERMEABLE CAPPING alternative could reduce the magnitude of the residual risk by interrupting the physical mechanism that transports contaminant mass from the soil to the groundwater and reducing the risk associated with exposure to inorganics.
Adequacy and reliability of controls	+	The IMPERMEABLE CAPPING alternative would provide adequate and reliable control of the infiltration and exposure to inorganics in the shallow soil. The cap would require long-term maintenance; however, the maintenance is relatively simple (e.g. erosion prevention and control). Other than routine maintenance, there should be no need to replace technical components. Should the remedial action require replacement at some future time, the magnitude of the threats/risks would be the same as those faced today. There is a high degree of confidence that the controls can adequately handle potential problems. Since no wastes are excavated, Land Disposal Restrictions would not impact this alternative.

AR300950

Table 6-5
Detailed Analysis – Institutional Controls & Impermeable Capping
Manufacturing Area

Remedial Technology – Institutional Controls & Impermeable Cap - Alternative 3		
Process Option		
Evaluation Criteria - Reduction of Toxicity, Mobility, and Volume through Treatment (-)		
Analysis Factor	Analysis Factor Rating	Remarks
Treatment process and remedy	NA	
Amount of hazardous material destroyed or treated	-	The IMPERMEABLE CAPPING alternative does not destroy or treat any of the COCs.
Reduction in toxicity, mobility, or volume	-	The IMPERMEABLE CAPPING alternative does not reduce the toxicity, mobility, or volume of the COCs.
Irreversibility of the treatment	NA	
Type and quantity of treatment residual	NA	
Statutory preference for treatment as a principal element	-	The IMPERMEABLE CAPPING alternative does not satisfy the statutory preference for treatment of the COCs.

AR300951

Table 6-5
Detailed Analysis – Institutional Controls & Impermeable Capping
Manufacturing Area

Remedial Technology – Institutional Controls & Impermeable Cap - Alternative 3		
Process Option		
Evaluation Criteria - Short-term Effectiveness (+)		
Analysis Factor	Analysis Factor Rating	Remarks
Protection of the community during remedial actions	+	The IMPERMEABLE CAPPING alternative may pose some additional risk to the community resulting from dust generated during construction. These risks are easily controlled and minor due to the minimal amount of potentially contaminated soil disturbed during construction.
Protection of workers during remedial actions	+	The IMPERMEABLE CAPPING alternative may pose some additional risk to workers resulting from dust generated during construction. These risks are easily controlled and minor due to the minimal amount of potentially contaminated soil disturbed during construction.
Environmental impacts	+	The IMPERMEABLE CAPPING alternative may pose some additional risk to the environment resulting from storm water run-off generated during construction. These risks are easily controlled and minor due to the minimal amount of potentially contaminated soil disturbed during construction.
Time until remedial response objectives are achieved	+	The IMPERMEABLE CAPPING alternative can be in place and operational within a relatively short time frame.

Table 6-5
Detailed Analysis – Institutional Controls & Impermeable Capping
Manufacturing Area

Remedial Technology – Institutional Controls & Impermeable Cap - Alternative 3		
Process Option		
Evaluation Criteria - Implementability (+)		
Analysis Factor	Analysis Factor Rating	Remarks
		Technical Feasibility
Ability to construct and operate technology	+	The IMPERMEABLE CAPPING alternative is a known method and is relatively easy to construct and operate.
Reliability of technology	+	The IMPERMEABLE CAPPING alternative is reliable if properly maintained and will not lead to schedule delays.
Ease of undertaking additional remedial action, if necessary	-	The IMPERMEABLE CAPPING alternative may impact the operation of the groundwater pump and treat system by reducing the infiltration rate. This may be an advantage that reduces the operation of the pump and treat system. However, without modeling the impacts are uncertain. Once constructed, the IMPERMEABLE CAPPING alternative may limit any future actions for the soils that would require any intrusive work.
Monitoring considerations	+	The effectiveness of the IMPERMEABLE CAPPING alternative could be readily monitored. During implementation of the IMPERMEABLE CAPPING alternative, the exposure pathways through which contaminants may leave the site can be monitored. If the monitoring failed, the additional risk is small due to the minimal exposure of COC impacted soil during construction.
		Administrative feasibility
Coordination with other agencies	+	The IMPERMEABLE CAPPING alternative would be relatively easy to coordinate with other regulatory agencies.
		Availability of services and materials
Availability of treatment, storage capacity, and disposal	NA	

Table 6-5
Detailed Analysis – Institutional Controls & Impermeable Capping
Manufacturing Area

Remedial Technology – Institutional Controls & Impermeable Cap - Alternative 3		
Process Option		
Evaluation Criteria - Implementability (+)		
Analysis Factor	Analysis Factor Rating	Remarks
services		
Availability of necessary equipment and specialists	+	The equipment and specialists needed to implement the IMPERMEABLE CAPPING alternative are readily available.
Availability of prospective technologies	+	The technologies needed to implement the IMPERMEABLE CAPPING alternative are readily available.

AR300954

Table 6-5
Detailed Analysis – Institutional Controls & Impermeable Capping
Manufacturing Area

Remedial Technology – Institutional Controls & Impermeable Cap - Alternative 3		
Process Option		
Evaluation Criteria - Cost (+)		
Analysis Factor	Analysis Factor Rating	Remarks
Capital Costs	+	$3.09 MILLION
Operating and maintenance costs	+	$1.12 MILLION

Note: A positive (+) rating factor indicates that the analysis factor has been met. A negative (-) rating factor indicates that the analysis factor was not met.

Table 6-6
Detailed Analysis – Institutional Controls & Excavation
Drum Disposal Area

Remedial Technology – Institutional Controls & Excavation - Alternative 1		
Process Option		
Evaluation Criteria - Overall Protection of Human Health and the Environment (+)		
Analysis Factor	Analysis Factor Rating	Remarks
How alternative provides human health and environmental protection	+	The EXCAVATION alternative reduces the risk on the site associated with all impacted soils.
Evaluation Criteria - Compliance with ARARs (+)		
Analysis Factor	Analysis Factor Rating	Remarks
Compliance with chemical-specific ARARs	NA	
Compliance with Action-specific ARARs	+	Land disturbance activities, such as grading and excavation, may generate fugitive dust emissions and promote erosion. Maintaining acceptable moisture content during excavation easily controls these dust emission. Storm water management and sediment controls will be implemented during excavation activities to prevent erosion. The Land Disposal Restrictions would most likely impact this option by requiring treatment of the soils prior to disposal.
Compliance with Location-specific ARARs	+	The site is located in the primary drinking water supply watershed. The soils above preliminary remediation goals would be excavated and disposed off-site, thereby protecting the off-site groundwater.
Compliance with other criteria, advisories, and guidances	NA	

Table 6-6
Detailed Analysis – Institutional Controls & Excavation
Drum Disposal Area

Remedial Technology – Institutional Controls & Excavation - Alternative 1		
Process Option		
Evaluation Criteria - Long-term Effectiveness and Permanence (+)		
Analysis Factor	Analysis Factor Rating	Remarks
Magnitude of residual risk	+	The EXCAVATION alternative allows reduces the residual risk to acceptable levels.
Adequacy and reliability of controls	+	The EXCAVATION alternative addresses this analysis factor as follows • The technology will most likely meet the performance specification. • No long-term management or monitoring is required for the deep soils. • No operation and maintenance functions must be performed once the remedy is completed. • There are no uncertainties associated with the long-term operation and maintenance. • There is no need for the replacement of system components. • There are no threats or risks associated with the replacement of the remedial action. • The Land Disposal Restrictions would most likely impact this option by requiring treatment of the soils prior to disposal.

Table 6-6
Detailed Analysis – Institutional Controls & Excavation
Drum Disposal Area

Remedial Technology – Institutional Controls & Excavation - Alternative 1		
Process Option		
Evaluation Criteria - Reduction of Toxicity, Mobility, and Volume through Treatment (+)		
Analysis Factor	Analysis Factor Rating	Remarks
Treatment process and remedy	+	The specific treatment is unknown at this time; however presumed to be required at the TSDF by Land Disposal Restrictions. The treatment at the TSDF would address the principal threat posed by the COCs.
Amount of hazardous material destroyed or treated	+	All COC impacted material that exceeds the clean-up goals would be excavated and transported to the TSDF. All material received by the TSDF would most likely be treated prior to disposal.
Reduction in toxicity, mobility, or volume	+	Relative to the site, the toxicity, mobility, and volume are all reduced. From a bigger perspective, the toxicity, mobility, and volume would be addressed at the TSDF.
Irreversibility of the treatment	+	Treatment employed by TSDF presumed to be irreversible.
Type and quantity of treatment residual	+	The treatment residuals would most likely remain at the TSDF; however, the exact quantity and composition are unknown at this time. These residuals would be disposed at the TSDF and meet the requirements of the selected facility.
Statutory preference for treatment as a principal element	+	The EXCAVATION alternative would meet statutory preference for treatment by treating soils prior to disposal.

Table 6-6
Detailed Analysis – Institutional Controls & Excavation
Drum Disposal Area

Remedial Technology – Institutional Controls & Excavation - Alternative 1		
Process Option		
Evaluation Criteria - Short-term Effectiveness (0)		
Analysis Factor	Analysis Factor Rating	Remarks
Protection of the community during remedial actions	+	The EXCAVATION alternative would require controls in order to minimize potential risks to the community posed by airborne dust during excavation. These risks can be readily controlled using common methods.
Protection of workers during remedial actions	+	The EXCAVATION alternative would require controls in order to minimize risks to site workers posed by dust, exposures to contaminated soils, and vaporization of COCs. These risks can be readily controlled.
Environmental impacts	+	The EXCAVATION alternative would require controls in order to minimize impacts to the environment due to storm water run-off during excavation. These impacts can be readily controlled.
Time until remedial response objectives are achieved	+	The EXCAVATION alternative can relatively quickly addresses the threats and achieves remedial response objectives in a relatively short time period.

Table 6-6
Detailed Analysis – Institutional Controls & Excavation
Drum Disposal Area

Remedial Technology – Institutional Controls & Excavation - Alternative 1		
Process Option		
Evaluation Criteria - Implementability (+)		
Analysis Factor	Analysis Factor Rating	Remarks
		Technical Feasibility
Ability to construct and operate technology	+	The EXCAVATION alternative is relatively easy to construct using standard practices and methods. However, there is considerable uncertainty as to the extent of contamination in the subsurface for purposes of estimating volumes.
Reliability of Technology	+	Due to its simplicity, the EXCAVATION alternative is very reliable and would not lead to schedule delays.
Ease of undertaking additional remedial action, if necessary	+	The EXCAVATION alternative would not adversely impact the implementation of remedial actions at other OUs and would be a final remedy for OU 4.
Monitoring considerations	+	Exposure pathways during implementation can be monitored. In the event of a monitoring failure, there could be a minimal increase in risk to workers or the surrounding community. However, the potential increase is relatively small due to the low population density in the vicinity of the site.
		Administrative Feasibility
Coordination with other Agencies	+	The EXCAVATION alternative would require coordination with other agencies in order to transport contaminated material for off-site disposal. The EXCAVATION alternative was previously accomplished for the removal of contaminated soils and sludges.
		Availability of services and materials
Availability of treatment, storage capacity, and disposal services	+	Adequate treatment storage, capacity, and disposal services are available.
Availability of necessary equipment and specialists	+	Equipment and specialists are readily available to implement this alternative.

Table 6-6
Detailed Analysis – Institutional Controls & Excavation
Drum Disposal Area

Remedial Technology – Institutional Controls & Excavation - Alternative 1		
Process Option		
Evaluation Criteria - Implementability (+)		
Analysis Factor	Analysis Factor Rating	Remarks
Availability of prospective technologies	+	The EXCAVATION alternative employs methods, equipment and specialists that are readily available from more than one vendor and are sufficiently demonstrated. It is likely that competitive bids would be possible.

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Table 6-6
Detailed Analysis – Institutional Controls & Excavation
Drum Disposal Area

Remedial Technology – Institutional Controls & Excavation - Alternative 1		
Process Option		
Evaluation Criteria - Cost (-)		
Analysis Factor	Analysis Factor Rating	Remarks
Capital Costs	-	$27.36 MILLION
Operating and maintenance costs	+	$0 MILLION

Note: A positive (+) rating factor indicates that the analysis factor has been met. A negative (-) rating factor indicates that the analysis factor was not met.

Table 6-7
Detailed Analysis – Institutional Controls & Permeable Cap
Drum Disposal Area

Remedial Technology – Institutional Controls & Permeable Cap - Alternative 2		
Process Option		
Evaluation Criteria - Overall Protection of Human Health and the Environment (+)		
Analysis Factor	Analysis Factor Rating	Remarks
How alternative provides human health and environmental protection	+	The PERMEABLE CAPPING alternative reduces the risk on the site associated with all impacted soils.
Evaluation Criteria - Compliance with ARARs (+)		
Analysis Factor	Analysis Factor Rating	Remarks
Compliance with chemical-specific ARARs	NA	
Compliance with Action-specific ARARs	+	Land disturbance activities, such as grading and excavation, may generate fugitive dust emissions and promote erosion. These dust emission are easily controlled by maintaining acceptable moisture content during excavation of the top 0-2 feet of exposed contamination. Storm water management and sediment controls will be implemented during excavation activities to prevent erosion. The Land Disposal Restrictions may impact this option by requiring treatment of the soils prior to disposal.
Compliance with Location-specific ARARs	-	The site is located in the primary drinking water supply water shed. The PERMEABLE CAPPING alternative would NOT restrict COCs from leaching into the groundwater.

Table 6-7
Detailed Analysis – Institutional Controls & Permeable Cap
Drum Disposal Area

Compliance with other criteria, advisories, and guidances	+	The PERMEABLE CAPPING alternative would be designed to meet EPA's recommended design criteria for Subtitle D facilities. Subtitle D facilities are typically for non-hazardous landfills. However, because this site is NOT a landfill and the in-place groundwater treatment facility will address groundwater contamination, Subtitle D cap design requirements are appropriate for the PERMEABLE CAPPING alternative. Direct contact will be eliminated once the soil cap is constructed.

Table 6-7
Detailed Analysis – Institutional Controls & Permeable Cap
Drum Disposal Area

Remedial Technology – Institutional Controls & Permeable Cap - Alternative 2		
Process Option		
Evaluation Criteria - Long-term Effectiveness and Permanence (+)		
Analysis Factor	Analysis Factor Rating	Remarks
Magnitude of residual risk	+	The PERMEABLE CAPPING alternative allows reduces the residual risk to acceptable levels.
Adequacy and reliability of controls	+	The PERMEABLE CAPPING alternative addresses this analysis factor as follows • The technology will most likely meet the performance specification. • No long-term management or monitoring is required for the deep soils. • No operation and maintenance functions must be performed once the remedy is completed. • There are no uncertainties associated with the long-term operation and maintenance. • There is no need for the replacement of system components. • There are no threats or risks associated with the replacement of the remedial action. • The Land Disposal Restrictions would most likely impact this option by requiring treatment of the soils prior to disposal.

Table 6-7
Detailed Analysis – Institutional Controls & Permeable Cap
Drum Disposal Area

Remedial Technology – Institutional Controls & Permeable Cap - Alternative 2		
Process Option		
Evaluation Criteria - Reduction of Toxicity, Mobility, and Volume through Treatment (+)		
Analysis Factor	Analysis Factor Rating	Remarks
Treatment process and remedy	+	The specific treatment is unknown at this time; however presumed to be required at the TSDF by Land Disposal Restrictions. The treatment at the TSDF would address the principal threat posed by the COCs.
Amount of hazardous material destroyed or treated	+	All COC impacted material that exceeds the clean-up goals would be excavated and transported to the TSDF. All material received by the TSDF would most likely be treated prior to disposal.
Reduction in toxicity, mobility, or volume	+	Relative to the site, the toxicity, mobility, and volume are all reduced. From a bigger perspective, the toxicity, mobility, and volume would be addressed at the TSDF.
Irreversibility of the treatment	+	Treatment employed by TSDF presumed to be irreversible.
Type and quantity of treatment residual	+	The treatment residuals would most likely remain at the TSDF; however, the exact quantity and composition are unknown at this time. These residuals would be disposed at the TSDF and meet the requirements of the selected facility.
Statutory preference for treatment as a principal element	+	The PERMEABLE CAPPING alternative would meet statutory preference for treatment by treating soils prior to disposal.

Table 6-7
Detailed Analysis – Institutional Controls & Permeable Cap
Drum Disposal Area

Remedial Technology – Institutional Controls & Permeable Cap - Alternative 2		
Process Option		
Evaluation Criteria – Short-term Effectiveness (+)		
Analysis Factor	Analysis Factor Rating	Remarks
Protection of the community during remedial actions	+	The PERMEABLE CAPPING alternative would require controls in order to minimize potential risks to the community posed by airborne dust during PERMEABLE CAPPING. These risks can be readily controlled using common methods.
Protection of workers during remedial actions	+	The PERMEABLE CAPPING alternative would require controls in order to minimize risks to site workers posed by dust, exposures to contaminated soils, and vaporization of COCs. These risks can be readily controlled.
Environmental impacts	+	The PERMEABLE CAPPING alternative would require controls in order to minimize impacts to the environment due to storm water run-off during PERMEABLE CAPPING. These impacts can be readily controlled.
Time until remedial response objectives are achieved	+	The PERMEABLE CAPPING alternative can relatively quickly addresses the threats and achieves remedial response objectives in a relatively short time period.

Table 6-7
Detailed Analysis – Institutional Controls & Permeable Cap
Drum Disposal Area

Remedial Technology – Institutional Controls & Permeable Cap - Alternative 2		
Process Option		
Evaluation Criteria – Implementability (+)		
Analysis Factor	Analysis Factor Rating	Remarks
Technical Feasibility		
Ability to construct and operate technology	+	The PERMEABLE CAPPING alternative is relatively easy to construct using standard practices and methods. However, there is considerable uncertainty as to the extent of contamination in the subsurface for purposes of estimating volumes.
Reliability of Technology	+	Due to its simplicity, the PERMEABLE CAPPING alternative is very reliable and would not lead to schedule delays.
Ease of undertaking additional remedial action, if necessary	+	The PERMEABLE CAPPING alternative would not adversely impact the implementation of remedial actions at other OUs and would be a final remedy for OU 4.
Monitoring considerations	+	Exposure pathways during implementation can be monitored. In the event of a monitoring failure, there could be a minimal increase in risk to workers or the surrounding community. However, the potential increase is relatively small due to the low population density in the vicinity of the site.
Administrative Feasibility		
Coordination with other Agencies	+	The PERMEABLE CAPPING alternative would require coordination with other agencies in order to transport contaminated material for off-site disposal. Excavation was previously accomplished for the removal of contaminated soils and sludges.
Availability of services and materials		
Availability of treatment, storage capacity, and disposal services	+	Adequate treatment storage, capacity, and disposal services are available.
Availability of necessary equipment and specialists	+	Equipment and specialists are readily available to implement this alternative.

Table 6-7
Detailed Analysis – Institutional Controls & Permeable Cap
Drum Disposal Area

Remedial Technology – Institutional Controls & Permeable Cap - Alternative 2		
Process Option		
Evaluation Criteria – Implementability (+)		
Analysis Factor	Analysis Factor Rating	Remarks
Availability of prospective technologies	+	The PERMEABLE CAPPING alternative employs methods, equipment and specialists that are readily available from more than one vendor and are sufficiently demonstrated. It is likely that competitive bids would be possible.

Table 6-7
Detailed Analysis – Institutional Controls & Permeable Cap
Drum Disposal Area

Remedial Technology – Institutional Controls & Permeable Cap - Alternative 2		
Process Option		
Evaluation Criteria - Cost (+)		
Analysis Factor	Analysis Factor Rating	Remarks
Capital Costs	+	$1.83 MILLION
Operating and maintenance costs	+	$0

Note: A positive (+) rating factor indicates that the analysis factor has been met. A negative (-) rating factor indicates that the analysis factor was not met.

Table 6-8
Detailed Analysis – Institutional Controls & Impermeable Capping
Drum Disposal Area

Remedial Technology – Institutional Controls & Impermeable Cap - Alternative 3		
Process Option		
Evaluation Criteria - Overall Protection of Human Health and the Environment (0)		
Analysis Factor	Analysis Factor Rating	Remarks
How alternative provides human health and environmental protection	+	Controls exposure pathway by restricting contact with arsenic and cyanide contaminated soils and reducing infiltration and leaching of COC mass to groundwater.
Evaluation Criteria - Compliance with ARARs (+)		
Analysis Factor	Analysis Factor Rating	Remarks
Compliance with chemical-specific ARARs	NA	
Compliance with Action-specific ARARs	+	Land disturbance activities common to cap construction, such as grading and excavation, may generate fugitive dust emissions and promote erosion. These dust emission are easily controlled and minor due to the minimal amount of potentially contaminated soil disturbed during construction of the cap. During cap construction, erosion and sediment controls will be implemented.
Compliance with Location-specific ARARs	+	The IMPERMEABLE CAPPING alternative would restrict COCs from leaching into the groundwater.
Compliance with other criteria, advisories, and guidances	+	The IMPERMEABLE CAPPING alternative would be designed to meet EPA's recommended design criteria for Subtitle C facilities. It is important to note that this site is NOT a landfill. Design criteria for Subtitle C facilities were selected for this alternative strictly because Subtitle C facilities employ impermeable caps.

Table 6-8
Detailed Analysis – Institutional Controls & Impermeable Capping
Drum Disposal Area

Remedial Technology – Institutional Controls & Impermeable Cap - Alternative 3		
Process Option		
Evaluation Criteria - Long-term Effectiveness and Permanence (+)		
Analysis Factor	Analysis Factor Rating	Remarks
Magnitude of residual risk	+	The IMPERMEABLE CAPPING alternative could reduce the magnitude of the residual risk by interrupting the physical mechanism that transports contaminant mass from the soil to the groundwater and reducing the risk associated with exposure to inorganics.
Adequacy and reliability of controls	+	The IMPERMEABLE CAPPING alternative would provide adequate and reliable control of the infiltration and exposure to inorganics in the shallow soil. The cap would require long-term maintenance; however, the maintenance is relatively simple (e.g. erosion prevention and control). Other than routine maintenance, there should be no need to replace technical components. Should the remedial action require replacement at some future time, the magnitude of the threats/risks would be the same as those faced today. There is a high degree of confidence that the controls can adequately handle potential problems. Since no wastes are excavated, Land Disposal Restrictions would not impact this alternative.

Table 6-8
Detailed Analysis – Institutional Controls & Impermeable Capping
Drum Disposal Area

Remedial Technology – Institutional Controls & Impermeable Cap - Alternative 3		
Process Option		
Evaluation Criteria - Reduction of Toxicity, Mobility, and Volume through Treatment (-)		
Analysis Factor	Analysis Factor Rating	Remarks
Treatment process and remedy	NA	
Amount of hazardous material destroyed or treated	-	The IMPERMEABLE CAPPING alternative does not destroy or treat any of the COCs.
Reduction in toxicity, mobility, or volume	-	The IMPERMEABLE CAPPING alternative does not reduce the toxicity, mobility, or volume of the COCs.
Irreversibility of the treatment	NA	
Type and quantity of treatment residual	NA	
Statutory preference for treatment as a principal element	-	The IMPERMEABLE CAPPING alternative does not satisfy the statutory preference for treatment of the COCs.

Table 6-8
Detailed Analysis – Institutional Controls & Impermeable Capping
Drum Disposal Area

Remedial Technology – Institutional Controls & Impermeable Cap - Alternative 3		
Process Option		
Evaluation Criteria - Short-term Effectiveness (+)		
Analysis Factor	Analysis Factor Rating	Remarks
Protection of the community during remedial actions	+	The IMPERMEABLE CAPPING alternative may pose some additional risk to the community resulting from dust generated during construction. These risks are easily controlled and minor due to the minimal amount of potentially contaminated soil disturbed during construction.
Protection of workers during remedial actions	+	The IMPERMEABLE CAPPING alternative may pose some additional risk to workers resulting from dust generated during construction. These risks are easily controlled and minor due to the minimal amount of potentially contaminated soil disturbed during construction.
Environmental impacts	+	The IMPERMEABLE CAPPING alternative may pose some additional risk to the environment resulting from storm water run-off generated during construction. These risks are easily controlled and minor due to the minimal amount of potentially contaminated soil disturbed during construction.
Time until remedial response objectives are achieved	+	The IMPERMEABLE CAPPING alternative can be in place and operational within a relatively short time frame.

Table 6-8
Detailed Analysis – Institutional Controls & Impermeable Capping
Drum Disposal Area

Remedial Technology – Institutional Controls & Impermeable Cap - Alternative 3		
Process Option		
Evaluation Criteria - Implementability (+)		
Analysis Factor	Analysis Factor Rating	Remarks
		Technical Feasibility
Ability to construct and operate technology	+	The IMPERMEABLE CAPPING alternative is a known method and is relatively easy to construct and operate.
Reliability of technology	+	The IMPERMEABLE CAPPING alternative is reliable if properly maintained and will not lead to schedule delays.
Ease of undertaking additional remedial action, if necessary	-	The IMPERMEABLE CAPPING alternative may impact the operation of the groundwater pump and treat system by reducing the infiltration rate. This may be an advantage that reduces the operation of the pump and treat system. However, without modeling the impacts are uncertain. Once constructed, the IMPERMEABLE CAPPING alternative may limit any future actions for the soils that would require any intrusive work.
Monitoring considerations	+	The effectiveness of the IMPERMEABLE CAPPING alternative could be readily monitored. During implementation of the IMPERMEABLE CAPPING alternative, the exposure pathways through which contaminants may leave the site can be monitored. If the monitoring failed, the additional risk is small due to the minimal exposure of COC impacted soil during construction.
		Administrative feasibility
Coordination with other agencies	+	The IMPERMEABLE CAPPING alternative would be relatively easy to coordinate with other regulatory agencies.
		Availability of services and materials
Availability of treatment, storage capacity, and disposal	NA	

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Table 6-8
Detailed Analysis – Institutional Controls & Impermeable Capping
Drum Disposal Area

Remedial Technology – Institutional Controls & Impermeable Cap - Alternative 3		
Process Option		
Evaluation Criteria - Implementability (+)		
Analysis Factor	Analysis Factor Rating	Remarks
services		
Availability of necessary equipment and specialists	+	The equipment and specialists needed to implement the IMPERMEABLE CAPPING alternative are readily available.
Availability of prospective technologies	+	The technologies needed to implement the IMPERMEABLE CAPPING alternative are readily available.

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Table 6-8
Detailed Analysis – Institutional Controls & Impermeable Capping
Drum Disposal Area

Remedial Technology – Institutional Controls & Impermeable Cap - Alternative 3		
Process Option		
Evaluation Criteria - Cost (+)		
Analysis Factor	Analysis Factor Rating	Remarks
Capital Costs	+	$0.84 MILLION
Operating and maintenance costs	+	$0.30 MILLION

Note: A positive (+) rating factor indicates that the analysis factor has been met. A negative (-) rating factor indicates that the analysis factor was not met.

Table 6-9
Summary Analysis of Alternatives

Alternative	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-term effectiveness and Permanence	Reduction of Toxicity, Mobility, and Volume through Treatment	Short-term effectiveness	Implementability	Cost
Drum Disposal Area & Manufacturing Area							
No Remedial Action & Institutional Controls – ALT 1 (See Table 6-1)	-	-	-	-	+	+	+
Impermeable Cap & Institutional Controls – ALT 2 (See Table 6-2)	+	+	+	-	+	+	+
Manufacturing Area							
Excavation & Institutional Controls-ALT 1 (See Table 6-3)	+	+	+	+	+	+	-
Permeable Cap & Institutional Controls-ALT 2 (See Table 6-4)	+	+	+	+	+	+	+
Impermeable Cap & Institutional Controls – ALT 3 (See Table 6-5)	+	+	+	-	+	+	+
Drum Disposal Area							
Excavation & Institutional Controls-ALT 1 (See Table 6-6)	+	+	+	+	+	+	-
Permeable Cap & Institutional Controls-ALT 2 (See Table 6-7)	+	+	+	+	+	+	+
Impermeable Cap & Institutional Controls-ALT 3 (See Table 6-8)	+	+	+	-	+	+	+

Table 6-10
Greenwood Chemical Focused Feasibility Study
Cost Estimates

Alternative	Capital Cost (MILLION $)	O&M Cost (MILLION $)	Total Cost (MILLION $)
Drum Disposal Area & Manufacturing Area			
No Remedial Action & Institutional Controls – ALT 1 (See Table 6-1)	$ 0.11	$ 0.00	$ 0.11
Impermeable Cap & Institutional Controls – ALT 2 (See Table 6-2)	$ 3.93	$ 1.42	$ 5.35
Manufacturing Area			
Excavation & Institutional Controls- ALT 1 (See Table 6-3)	$ 78.30	$ 0.00	$ 78.30
Permeable Cap & Institutional Controls- ALT 2 (See Table 6-4)	$ 5.91	$ 0.00	$ 5.91
Impermeable Cap & Institutional Controls – ALT 3 (See Table 6-5)	$ 3.09	$ 1.12	$ 4.21
Drum Disposal Area			
Excavation & Institutional Controls- ALT 1 (See Table 6-6)	$ 27.36	$ 0.00	$ 27.36
Permeable Cap & Institutional Controls- ALT 2 (See Table 6-7)	$ 1.83	$ 0.00	$ 1.83
Impermeable Cap & Institutional Controls- ALT 3 (See Table 6-8)	$ 0.84	$ 0.30	$ 1.14